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THE INTERNATIONAL EXHIBITION OF 1876.

THE CORLISS BEVEL GEAR CUTTER.

No. 30.

THE cutting of bevel gear-wheels so that they shall have that exact symmetry and mathematical and mechanical perfection which are given to the spur gear-wheel, and which are indispensable to their perfect working, is a problem which has been found, perhaps, more difficult of solution than any which has been presented to the mechanician. To cut perfectly a spur or similar gear, the mechanical problem has been, simply, to make a circular or disk milling cutter, having for a section of that part of it containing the cutting teeth the form required for the space to be cut between two teeth of the given wheel; and a machine which would accurately divide the circle into the required number of parts, hold securely the wheel while being cut, and rotate and pass this milling cutter across the face of the wheel; such an apparatus, adjustable to the varying conditions, as to dimensions of gear, number of teeth required, etc., has long been in use, and the cutting of spur gearing has for many years been easily, perfectly, and cheaply done.

To cut a bevel gear, however, requires the application of entirely different principles and mechanism. Previous to the invention by Mr. George H. Corliss of a machine for this purpose, patented in 1849, and at that time illustrated in Appleton's "Dictionary of Mechanics," and almost universally since by others, the method of preparing a bevel-wheel within reasonable accuracy has been, to place the cast blank or wheel in the ordinary gear-cutting machine, such as is constructed to permit of the cutting being done at different angles with the axis of the gear to be cut, and to pass through twice on a line corresponding to the bottom of the space between teeth and one side of the bottom of the flank of the tooth, a revolving milling cutter, having such a form of section through the cutting part as corresponds to the correct form of the larger end of the tooth, but of such thickness as to preserve all the metal necessary to the perfection of the small end of the tooth by subsequent operations, afterwards dressing down by hand work the small ends of the teeth to their proper shape, and then in the same way the whole body of the tooth; the only part of the new tooth, when finished, receiving a correct form from the cutter being the large extremity. The small ends of the teeth are sometimes given the proper form by using a second cutter having the exact outline of that part of the tooth and entering it from the smaller towards the larger end a sufficient distance only to impart the proper form to it, then dressing by straight-edge, chisel and file, the body of the tooth between these extreme points to correspond; but at best this is no more correct than hand-work can make it, and is most laborious and expensive.

It is impossible to cut a bevel gear correctly with a revolving cutter, whether it be the disk form whose axis is in position of a tangent to the periphery of the wheel to be cut or nearly so, or that kind which is sometimes used for the cutting of very large spur gearing, which is carried upon the end of a spindle whose axis occupies nearly the position of a radius of the wheel. Let the controlling mechanism be what it may, neither of these nor any revolving toothed cutter can finish the tooth of a bevel wheel correctly, unless such cutter could be made to be capable of a uniform contraction or expansion in every dimension as it was passed through.

A tooth or space between two teeth in a bevel wheel is a symmetrically reduced form, from the largest to the smallest end of the tooth or space, and any straight line drawn upon them and touching homologous points throughout the length of the tooth, if produced towards the smaller diameter of the wheel, will intersect at a common point, and that is identical with the point at which the axes of any pair of bevel wheels intersect. The only way then in which a wheel of this kind can be correctly cut is, by the use of a cutter which will operate practically upon a line, as is the case, for instance, with the ordinary "diamond point" planer tool; and it must be actuated by mechanism such that the lines upon which it moves when cutting must be those which converge to the common point of intersection. This applies of course only to the finishing of wheels which have been cast in the rough, leaving sufficient material in the teeth to finish. If the given wheel is cast solid, it may be put in the ordinary cutting engine, and with a disk or rotating cutter having parallel sides, parallel grooves may be cut, not exceeding in width the smallest part of the small end of the space to be left between the finished teeth, and then finished in the machine under consideration; or the same preparatory work may be done on such a wheel in the Corliss machine, although, perhaps, not quite so cheaply.

To dress up accurately the face and flank of the tooth of a bevel gear wheel and the bottom of the intervening space with a tool, the cutting point of which should reciprocate practically upon the converging lines of a mathematically correct wheel, and tracing on the finished surface such narrow lines as are left by the planer tool with a comparatively fine feed, is the problem, the solution of which has been essayed by Mr. Corliss, and the first prerequisite was to make that part of the machine which carried the tool reciprocate on slides which, while they permitted of the cutting point of the tool always following the converging lines, should be capable of motion in all directions upon the point of convergence as a centre; and the problem was the more difficult from the fact that, in order to produce the mathematically correct wheel, no part of the machine itself could occupy or be allowed to move on the convergent lines, as the cutting point of the tool could only be permitted to follow them.

As stated above, this was practically done by Mr. Corliss in 1849, and a machine which was the parent of the one under consideration has been in use by him since that time. It was not, however, of such proportions as to be capable of cutting the large bevels to be used on the Centennial shafting; and a more complete and elegant solution of the problem is to be found in the present machine.

Of the illustration, Fig. 1 is a side elevation, Fig. 2 a front elevation, and Fig. 3 a plan view of the machine—all of them given partly in section to show interior mechanism; Fig. 4 is a side and Fig. 5 a back view of the device for moving the dividing wheel; Fig. 6 is a top view, part in section, and Fig. 7 a side view of the feeding and guiding gear; Fig. 8 is an end and Fig. 9 a back view of the mechanism for securing the dividing wheel, and with it the wheel to be cut, at the division used, and for the adjustment of the cut taken; Fig. 10 is a top and Fig. 11 a side view of the rack and pinion giving motion to the cutter slide, and Fig. 12 is a sectional view of the same; Figs. 13 and 14 are two views of the slotted link for insuring an exact recurrence of the divisions. In these figures, like letters refer to like parts.

A is the frame, and B a large hollow spindle turning therein, to either end of which the bevel to be cut B' and the index wheel D are secured. At right angles to this runs in suitable bearings the shaft S'', carrying a pinion P, to impart motion to the cutter slide S'. Motion is imparted to this shaft in both directions by means of the wheels and pulleys W, W, etc., similar to the driving mechanism of the ordinary iron planer. The shafts S'' and B occupy a position such that their intersection is identical with the point of intersection of the lines traversed by the cutting point of the tool. The slide frame S oscillates vertically upon the shaft S'' as a centre, its outer end carrying the feeding and guiding gear, being supported as hereafter shown.

This slide frame oscillates also laterally upon the stud *f*, whose axis also intersects the common point of convergence of the cutting lines. The pinion P gears into a rack R, one end of which is secured to the cutter slide S', and the other sliding in and supported by a prolongation downward of the slide frame S.

In this way, S is adjustable in all directions upon the centre C, which is the common point of intersection above referred to, and the cutting point of the tool C', which is made to project the proper distance out of S', must travel in the required lines converging at C. The cutter slide S' carries upon it a "dog," which comes in contact with collars on the rod *r* (neither "dog" nor collars shown), adjustable for varying lengths of stroke, which at the required limits gives motion to the arm *a'* and disk *d*, carrying the arm *a*. On the lower end of the latter is a friction roller traversing an inclined groove, which imparts sliding motion to the rod *r'*, and thus to the belt shippers *r''* attached to it; in this way the reversing is accomplished just as in the ordinary planer. The rod *r* at its upper end connects to a lever *o*, vibrating on the centre *o'*, to the lower end of which is connected a wedge I. Motion is thus given as well to the arm *o''*, which connects again with *o'''* to operate a ratchet feed through the wheels G and *x*, the pinion *x'*, and the circular rack R', the latter being secured to the circular ways *y*, *y*, on the frame A.

P is a steel pin vibrating upon the stud *p'*, round on its outer and of wedge form on its inner end; this pin is pressed against a guide or template of steel *g*, secured to the frame A, having upon its edge towards the pin an enlarged outline of the tooth to be cut, slightly modified to compensate for the round form of the pin; that is to say, the form of this guide is that which the flank and face of the tooth to be cut would have if produced to the same distance from the point of convergence as that occupied by the guide. The pin is kept against the guide by means of the cord V leading over the pulleys P'', P'', and carrying a weight below the floor. When the wedge I is pushed in at the end of the cutting stroke by the action of the rod *r*, the whole slide frame, and with it the tool, is moved laterally a little to relieve the tool on the back stroke. The cord V is attached to either one of two levers *h*, according as one or the other side of the tooth is being operated upon.

Another cord V', leading over pulleys P' P', etc., similarly weighted below the floor, is attached to the upper end of the slide-frame A at A², to counterbalance its weight. W' is the pulley which receives motion from the line shaft.

The tool used in this machine is a modification of what is technically known as a side tool—that is, while cutting down the faces and flanks of the teeth, which, of course, is the principal operation, and for finishing, a very light cut is taken, with the tool made very hard, in order that, in going all round a large wheel—which must be done without change of tool—there shall be no appreciable wear to that very small part of the cutting edge which makes contact with the iron while cutting, for any one setting of it. If this method of cutting bevels has any weak point it is this, and every precaution must be necessary to insure that the first tooth shaped shall not be smaller than the last from the wear of the tool. To compensate for the very slight wear which must inevitably occur, even under all precautions, the wheel may be gone round in different direction for the different sides of the teeth; at least such a plan would practically correct the wear, every thing being equal.

D is the dividing wheel having index holes on its face (not shown) in several rows, which are divisible for different numbers of teeth. This wheel has teeth upon its edge, into which a small bevel pinion works, driven by a hand wheel H'', for the purpose of moving the wheel from one tooth to another, as shown in Figs. 4 and 5.

A very ingenious and thoroughly good and solid method of securing this wheel to the shaft is that of having two rectangular keys let in to the shaft and hub of the wheel in such a way that two sides and the included angle are in the shaft, while the opposite two sides and included angle are in the hub. These keys are not tapered, but are so placed that they converge towards each other at the point, so that in forcing either inward it reacts upon the other and effectually prevents any possibility of "back lash" between the wheel and shaft. These keys have projecting heads which are drilled to permit of the passage of a stud secured in the hub, upon which a nut serves to force in the keys as desired. This is an extremely solid and reliable plan.

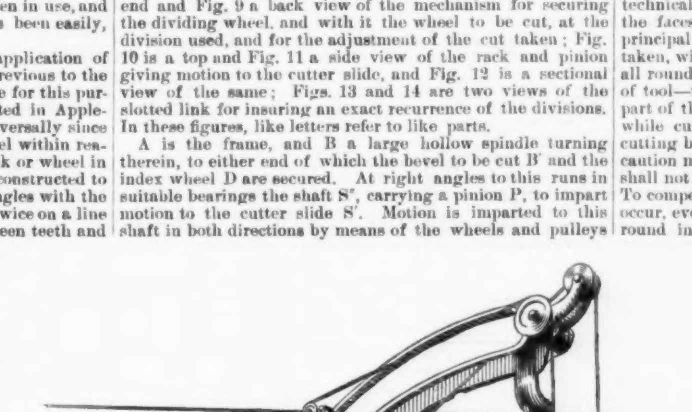
That part of the frame marked B'', Figs. 8 and 9, carries an adjustable jib, L, which is made to bear upon the outer edge of the dividing wheel to prevent lateral vibration; a link, J', Figs. 13 and 14, having at the end which receives the pin J a slot, ending in an offset, and at the other, pivoted to J², is connected to the slide J''. Beneath it is a thin plate, K, attached to the under side of the slide, and bearing on the face of D, to prevent its too free motion, as well as forming, on its upper end a limit for the position of the pin J when inserted for a new tooth. When all is adjusted for a new tooth, the pin J occupies the offset end of the slot in the link J'. This link is adjustable as to length by means of the double nut N². To move from one tooth to another in the wheel being cut, the pin J is removed from the division hole, and the wheel moved, by means of the hand wheel H'', until it can again be inserted in the proper hole for the next tooth. To adjust the cut to be taken, the whole indexing arrangement is moved by means of the hand wheel H, shaft H', pinions *b*, and slide J'', and, of course, remains as set until the wheel has been gone entirely round under the new cut.

The slide-frame S, and all attached to it, having a small lateral motion upon the stud *f*, while the pin *p* is following the form of the template *g*, as well as when the tool is relieved upon the back stroke by the wedge I, it is plain that the ordinary solid rack could not work upon the pinion P, and be capable of this lateral motion upon P, as a centre, without causing the teeth to bind; this rack is therefore to permit of such motion made as shown in Figs. 11, 12, and 13. The teeth *t t* are made with cylindrical shanks which fit easily into holes bored in the bar, forming the body of the rack. They are secured in place by the washer *n* and screw *n'*, and do not quite touch each other at the shoulders, where they join to form the bottom of the space, in order that, as the frame S vibrates upon *f*, the teeth in contact with the pinion may have a slight rotation upon their cylindrical shanks, and thus accommodate themselves to the required slight angle through which the slide-frame moves.

Figs. 6 and 7 are enlarged views of the mechanism for feeding down the cut, releasing the tool on the back stroke, and shows the place of attachment of the counter-balance cord at A².

The history of this machine is quite a peculiar one, and the

(Continued on page 788.)



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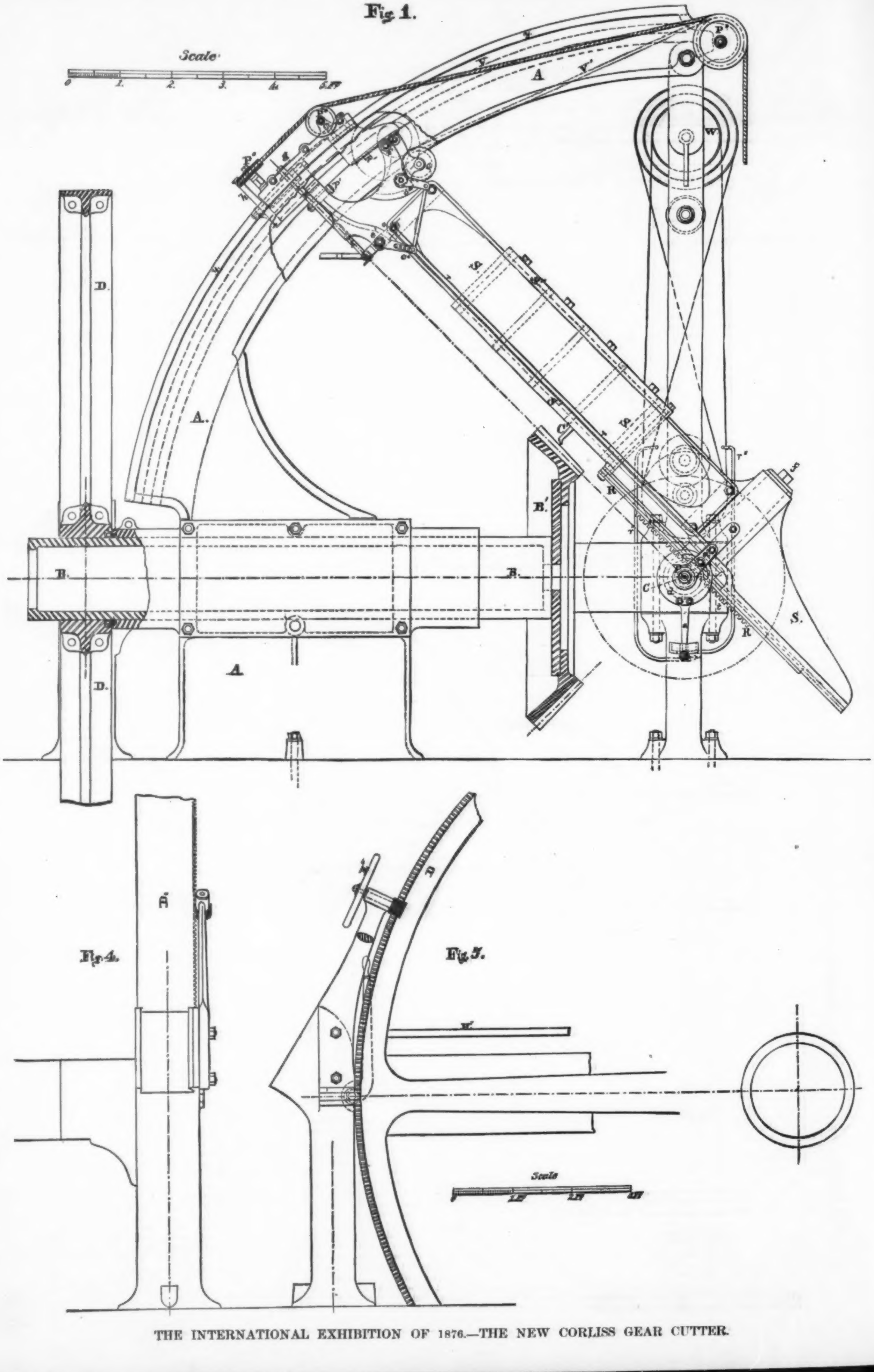

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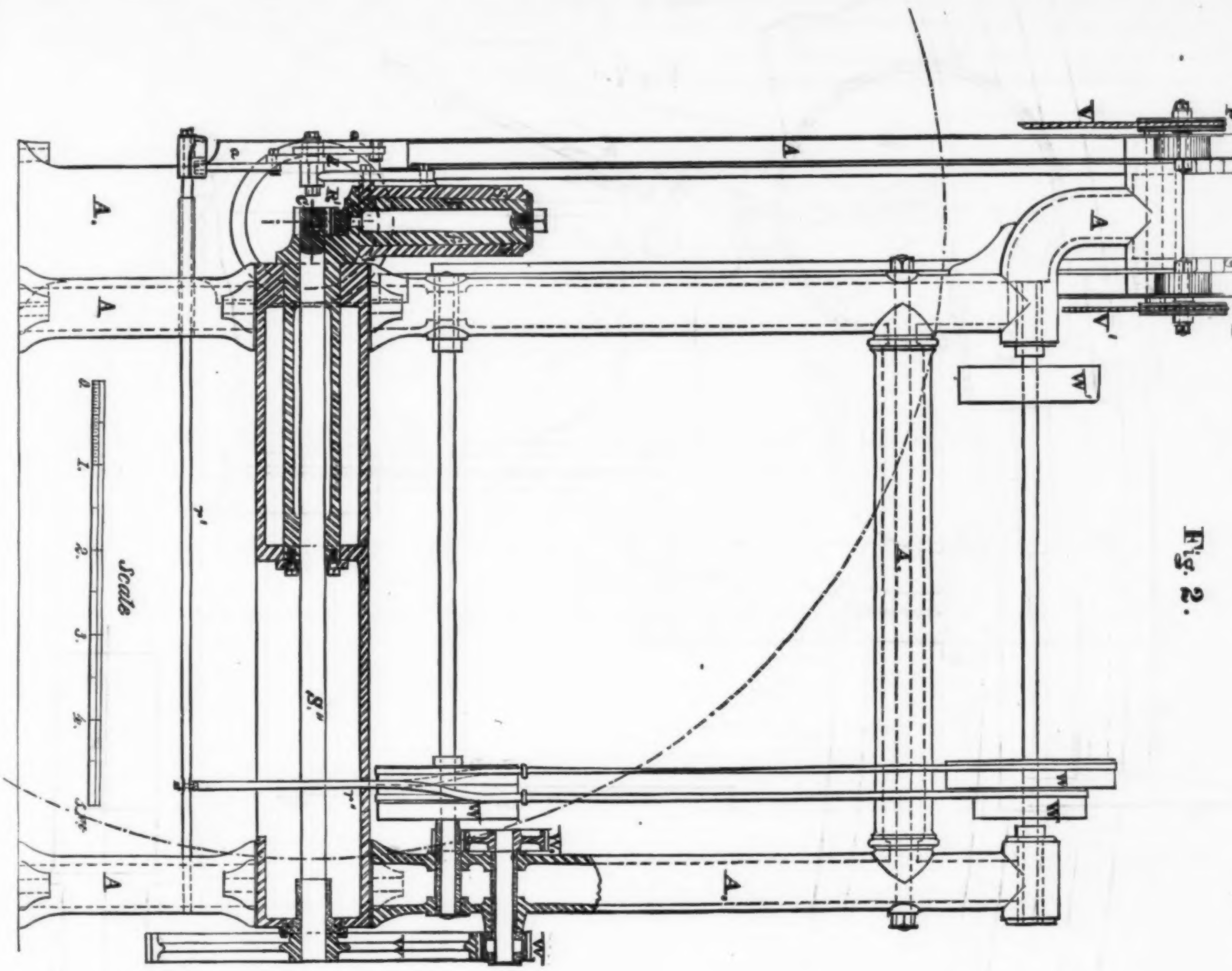

Fig. 2.

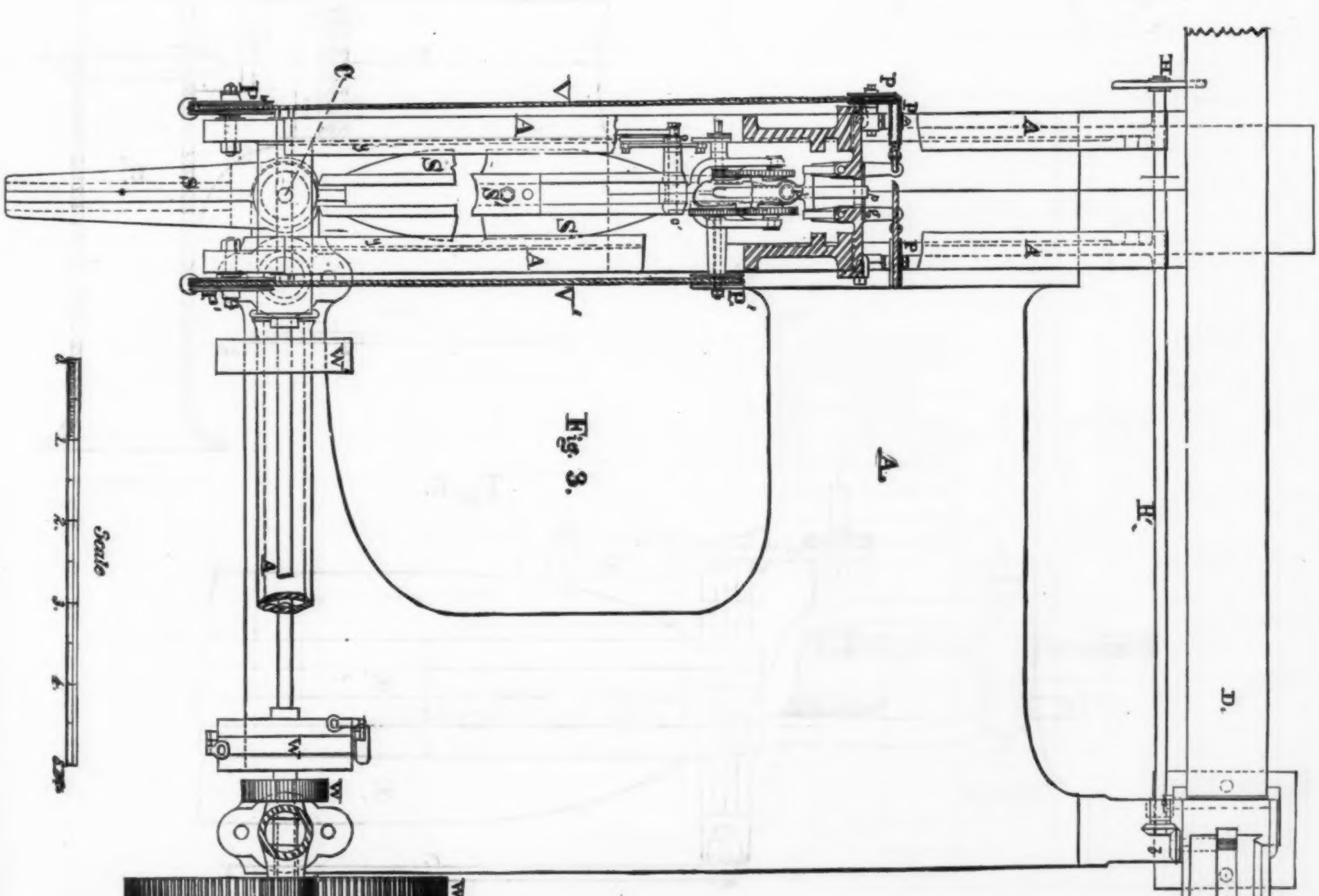

Fig. 3.

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Fig. 7.

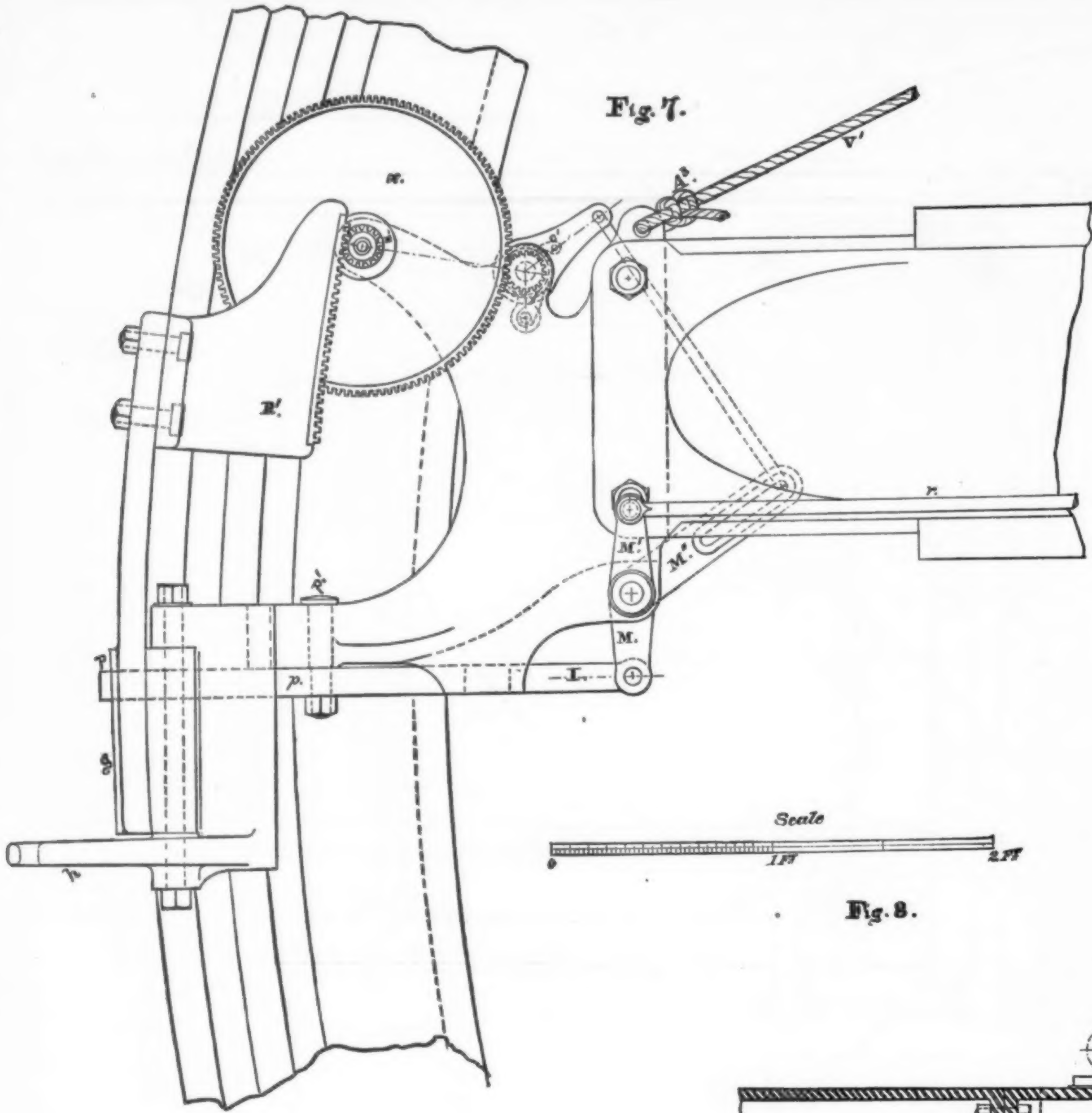


Fig. 8.

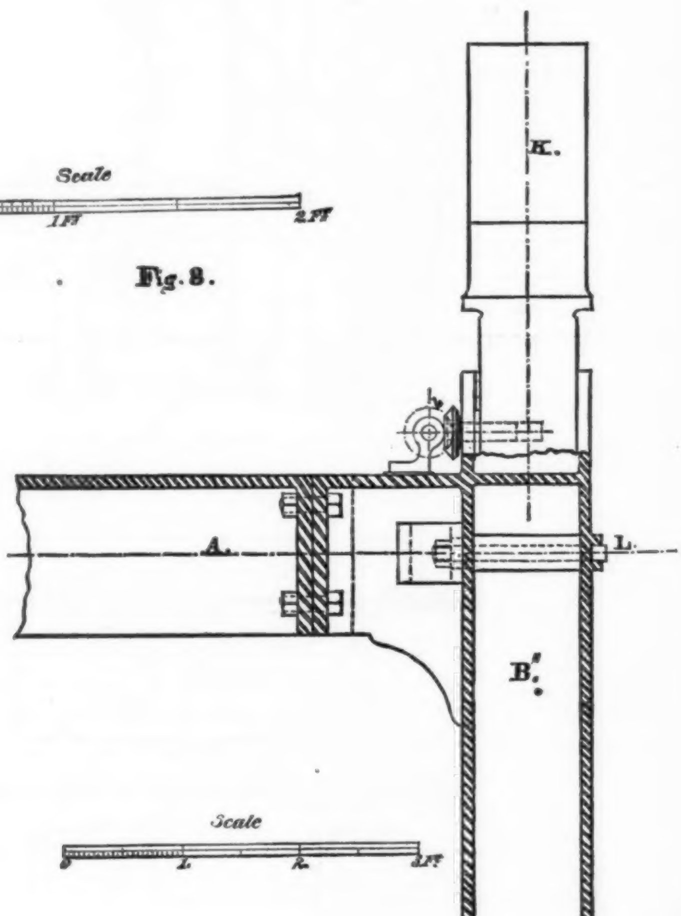
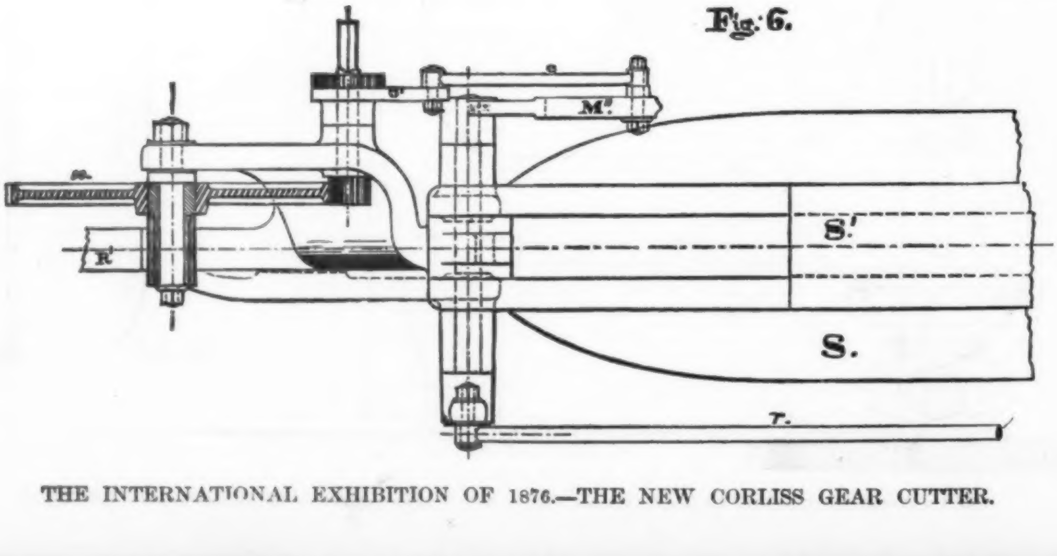


Fig. 6.



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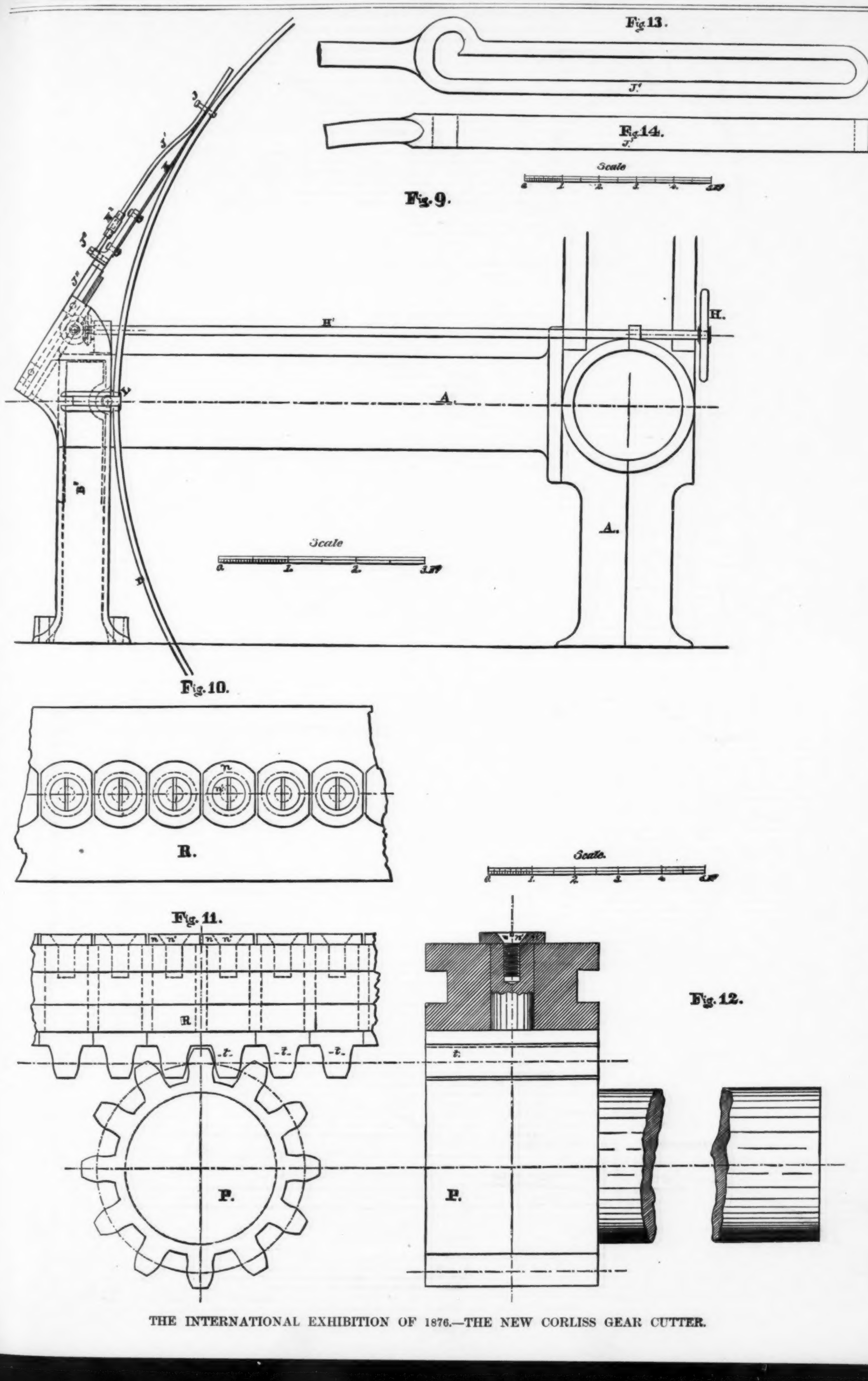


THE INTERNATIONAL EXHIBITION OF 1876.—THE NEW CORLISS GEAR CUTTER.

(Continued from page 783.)

fact that it was hurriedly designed for an especial case renders the exceptionally ingenious ideas developed in it the more creditable to the designer. When Mr. Corliss decided upon the particular arrangement of the subterranean shafting, which was adopted to transmit the power of his large beam engines to the eight lines of shafting in Machinery Hall, he saw the necessity of having something better for the four large trios of bevel wheels than could be gotten by any methods then in use, if that part of the work was to equal in mechanical perfection and smoothness of performance that which he designed should attach to the remainder of the work. He therefore determined to elaborate the principles of his first patented machine, and incur the large expense necessary to the production of, for the first time, a machine which should cut such large bevel wheels mathematically as correct as the great spur wheel and its pinion, immediately connected to the engines. This machine was therefore designed after the wheels which they were to cut were in existence, and both wheels and machine have been on exhibition in Machinery Hall, where they were to be seen in operation daily. The very ingenious devices incorporated in this machine, its completeness, perfect working, and the exactness of the work done upon it, together with the production of it in so short a time, and under the circumstances above enumerated, illustrate very perfectly the capacity both of the men and the establishment where it was produced.

Altogether this country has good cause to be proud of the showing of Geo. H. Corliss at its Centennial.

To illustrate what mechanicians generally think of this machine, I append the report of the Committee of Judges upon it. It is to be said, however, that, at the request of Mr. Corliss, and on the ground that nothing which he exhibits was entered for award (he being one of the Centennial Commissioners), this report was withdrawn as a basis of award:

JUDGES' REPORT.

"GROUP 21.—Product—Bevel Gear Cutter. Exhibitor, George H. Corliss, Providence, R. I.

"The undersigned, having examined the product herein described, respectfully recommend the same to the United States Centennial Commission for award, for the following reasons, viz.:

"For originality in design of one of the grandest tools which has ever been constructed for its particular purpose. The special function of this machine is to plane the teeth of bevel wheels of the heaviest class of mill gearing. It is constructed on the principle of copying the required mathematical lines from an accurately made steel copy which the machine traces, and by its mechanism transfers the form with rigid accuracy to the teeth of the wheel under operation, imparting to each tooth not only the mathematical subdivision, but shapes both sides with the utmost precision, and in a manner so perfect as to require no hand labor afterwards.

"In the design of this machine great freshness of originality has been lavishly displayed throughout, and although this originality does not refer to the primary idea, nor to the material embodiment of that idea into a working machine, both having been done before, yet no less merit is due to the designer of this tool, because its originality consists in the working out of an entirely new order of development by a rigid process of induction, whereby the accumulated stores of mechanical knowledge of an inventive mind are geometrically redistilled into a new system that exhibits refinement in every detail of construction, in order to obtain mathematical accuracy on a grand scale and avoid the possibility of error. The mathematical numerical division is obtained from the periphery of a broad-surfaced wheel, fifteen feet in diameter, by means that hold the system fast as a rock, and which can be adapted to any division or number of teeth that may be required in practice. Much skill and ingenuity are shown in the arrangements to secure steadiness, and to absorb all slackness of the mechanism between the tooth under operation and the dividing wheel. Still more especially is to be noted the admirable manner of double-keying the dividing wheel on its axis, and the adaptation of the index plate for accurate adjustment, whereby the primary adjustment of a particular wheel can be made the best of when fixed in the relationship of the rough teeth to the divisions on the dividing part of the apparatus. By this means, adjustments may be remodified as found necessary.

"The prominent feature of this machine is a swinging radial arm or frame, which is in equilibrium and free to move in any direction. This arm traces the steel copy of the required tooth; it also carries a saddle with cutting instrument. Its position is parallel with the line of each cut, and its centre of motion is the mathematical point in which the lines of the cone terminate. The mechanism employed to convey the motion to the cutting instrument upon a pendulous sort of frame, evinces great ingenuity. The device employed is a rack, but to accommodate the varying positions of the frame, the tooth of the rack conforms itself to the altered condition in which it has to work with reference to the driving pinion, which revolves in a fixed bearing. The automatic shifting motion for controlling the stroke and the arrangement for working the feed motion are all of an original character, and so finely constructed is the whole machine that a belt 1¼ inch in breadth is sufficient to set the machine in continuous steady motion.

"An exuberance of freshness pervades the whole, and the most prominent characteristic of the entire structure is a grand, noble simplicity, which only a master mind could conceive and bring to maturity."

Approval of group of Judges.

(Signed) AUGUST GOBERT (fils),
F. PERRIER,
FELIX REIFERT,
C. A. AUGSTROM,
JOHN A. ANDERSON,
GEO. H. BLELOCK,
W. F. DURFEE.

Signature of Judge,

(Signed) JOHN ANDERSON, LL.D., C.E.

In my last letter on the Corliss engines, published in No. 26 of this journal, the types made me place the steam pressure used at "60" lbs., whereas it should have been 16. This error was of course apparent to those interested sufficiently to investigate, as the figure did not accord with others given in the same letter. It will, however, be as well to make the correction here.

J. T. H.

IN the process for determining the amount of gold in pyrites, by M. H. Schwarz, he melts the gold with fine iron turnings under salt, and treats the sulphide thus formed with dilute sulphuric acid. After washing and drying the residue he roasts it, and then mixes it with a little borax and some lead, melts in a muffle, and, finally, cupels the little globules thus obtained.

SURGICAL APPLIANCES AT THE CENTENNIAL.

OF the large quantity of materials which have been tried for splints, it is probable that plaster-of-paris has, at this time, most advocates. As a St. Louis surgeon remarks, whose article I was lately reading, "this material is adaptable to every emergency demanding such restraint."

But the most recommendable method of using gypsum seems still open to question. It requires a body or filling in order to give it firmness and lightness, and what shall this be? I was well pleased with the "gypsum and hemp combination splint" exhibited among the surgical matters in the German section. They are used in the Surgical Hospital of the Royal University of Königsberg, of which Dr. Schœnborn is director. The hemp is spread over the limb in a layer of half an inch in thickness, and is retained there while the gypsum is applied upon it. In a few minutes the plaster hardens, and a second coat can be laid on if required. This is much simpler than the elaborate bandaging system which used to be employed, and has less danger of interfering with the circulation of the part.

In the Austrian department there is a very similar set of splints to be seen, such as are used in the surgical department of the Vienna General Hospital. They are of cotton and gypsum, and have the advantage of "movable flaps," the splint being prepared in sections, so that one piece at a time may be removed for dressing, inspection of the surface, etc. This saves the old and awkward plan of cutting holes in the splint.

Still another variety of plaster splints may be found in the department of the Netherlands, in the Main Building. These are the "plaster bandages" of Dr. A. Mathysen, and may be briefly described as follows: Three pieces of flannel are cut and fitted to the member; the one destined to lie between the other two is coated with gypsum on both sides, the other two only on one side, that which is to come in contact with the inner, double-coated piece. By this arrangement the splint is rendered cleanly, firm, light, and agreeable to the skin; there is no compression from bandages, and they are easily fitted and readjusted. They have been in use in the Netherlands for a number of years, and they must have been satisfactory, as their inventor has been awarded a red cross decoration for them, and La Société Nederlandaise, for the relief of the wounded in war, gives them its recommendation.

I have in a previous letter referred to the straw splints and bandages shown among the articles in military surgery in the German exhibit; but I have yet to mention the sheet-metal splints of Dr. Guillerz, of Brussels. These are to be seen in the Belgian department of the Main Building. They are of sheet lead, or a composition resembling it, and are pierced with a multitude of circular holes, to allow of transpiration, something like a "porous plaster." The inventor claims for them that they were used with great advantage on the battle-fields of the Franco-German war. A sheet of the metal can be carried without occupying much space, and can be moulded by the hands of the surgeon on the field to a wounded member, thus providing for safe transportation.

The principal English exhibitors in this line of surgical appliances are Lang, Jonas Jules, and F. C. Rein & Son, of London, and the Glasgow Apothecaries' Company; but I did not notice among their displays any special novelty in the line of splints.—*Medical and Surgical Reporter.*

ENGLAND AND THE CENTENNIAL.

THE more I see of the Exposition, says a Washington *Critic* letter, the more I am convinced of the debt of gratitude we owe to England for the prominent part she has taken in the enterprise, and when I recall the indifference and apathy that prevailed when Colonel John W. Forney first went abroad, the more I am impressed with the inestimable services he rendered in inducing the authorities to come over and help us to celebrate our Centennial anniversary. The art treasures themselves from the royal collection and the historical pictures of priceless value find a resting-place in Memorial Hall, and the ceramic, silver-ware, bronzes, tiles, chemicals, cloths, carpets, and, indeed, every branch of manufactures, are exceedingly well represented.

Not England alone, however, but all her provinces and colonies are here. Even India and New Zealand and Australia have collections more varied than some of the nearest countries. The New Zealanders have come seventeen thousand miles, and I am glad to learn that the larger part of their exhibit has been donated to the Government, and will be placed in the Smithsonian Institute at the close of the Exposition. Looking at the register in the New Zealand pavilion, I was surprised to find how large a number of people have been here this summer. Some of our own States and Territories have not been nearly so well represented. The Canadians have done nobly.

BRITISH MANUFACTURE OF SMALL ARMS.

UNDER this generic term are classed muskets, rifles, carbines, revolvers, pistols, and sword and other bayonets, most of which, being of exceedingly complex manufacture, require many different processes in most ingeniously designed machines, as well as some small amount of hand labor, before being handed over to the inspector for viewing and testing. This branch of industry is extensively carried on at the Small Arms Factory, Smallheath, near Birmingham, under the management of Major-General Dixon, which finds employment in busy times for about 1500 men, and is capable of turning out complete as many as 2000 rifles a week. This production can, if necessary, be increased to 3000, if what is called "double shift," or a relay of men, be employed in some of the departments.

At this establishment none but walnut wood, chiefly obtained from Italy, is used for the stocks of firearms, though inferior stocks are made of beech. The block of wood, rough-sawn out of 2½ inch plank, is made to revolve in a kind of lathe called a rough-stocking machine, the tool of which advances and recedes, so as to give the required shape, in accordance with the contour of a "former" or cast-iron counterpart of the stock. The result is that any number of stocks are identical in form, one machine alone being capable of turning 600 per week. One especial feature in the working of this machine, and all others in the same department, is, that it is not only self-acting, but also stops of itself as soon as it has accomplished its task, or, to speak in more precise and technical language, the feed stops as soon as the cut is finished.

After the general external form has been given to the stock, the groove for the barrel is cut out by a machine for that purpose. It is then smooth-turned, and afterwards transferred to the lock-bedding machine, by which the recess is made for receiving the lock. In this machine there is a stationary bed-plate, on which the stock is fixed. Loose on the central spindle is a circular frame, carrying four drills, and formers in pairs; a large pulley revolves above the frame, and on the lever being depressed, a small pulley on the drill spindle is driven rapidly by friction. When the work has been performed by that pair, a catch is loosened, and the frame revolves until the next pair are brought into position, and so on. The consequence is that the stock is quite ready to receive the various parts made of iron or steel, and, after a little smoothing, and a coat of linseed-oil, the stock is perfectly complete. All these machines have either been designed by the officials at the works, or have been improved by them from American models.

All the metal portions of the stock and lock are stamped out while hot, between dies, by means of "drops" and steam-hammers, the "flash," or rough part left at the joint, being afterwards removed by a trimming press after the nature of a punching machine; but, previous to this, the work is annealed and pickled, to soften the metal and remove the scale. Trigger-guards for Snider work are drawn out under a Ryder hammer, and the steel "shoes," containing the action of the Martini-Henry rifle (the stock of which is in two parts), are forged under a 15 cwt. Davey hammer. Another hammer of this same power afterwards stamps the "shoe," a mandril having been driven into the hole drifted by the first hammer.

Barrels are not at present made at the factory, although rolling-mills and furnaces have been erected for the purpose, but are obtained with a hole ready drilled through them. The barrel is first rough bored, then turned or "stripped," as it is called, in three different lathes; *i. e.*, three cuts are taken off. The barrel is next polished in a vertical machine, five being worked together, up and down, like so many pump-rods, twisting at the same time between blocks of wood fed with emery and oil, and kept against the barrel by springs. Then comes the fine boring. Six barrels are laid on a machine table, while steel rimers, ground to the right size and of square section, are made to revolve in their spindles, the barrels being gradually brought up to them by means of a weight passing over a pulley. To keep the "bits" steady, strips of wood of segmental section are placed over the sides of the rimer, packed up as required with slips of paper. In the Martini-Henry rifle the bore is 0.449 of an inch. The rifling in the same barrel consists of seven shallow grooves, making one turn in 20 inches. This operation is performed by an ingeniously devised machine capable of rifling to any pitch; but which can not well be described without elaborate drawings. The machines are inclined, so as to allow the soapy water forming the lubricant to run down the barrel. The breach end of the barrel is finished by milling machinery, as also are the several parts of the lock. In all cases the system of working with a former is adopted, in order to ensure the interchangeability of parts. The setting of the barrel is performed between the boring and stripping operations by blows of a hammer, before turning, and a mallet afterwards, the workmen being able to ascertain whether the barrel is straight or not by looking through it, and noting how the shadow of a horizontal line falls inside. The barrels are proved twice; 1st, after boring, with 7½ drachms of powder, 1¼ ozs. of lead, and a cork wad; and again after rifling and the addition of the lock, this time with 5 drachms of powder. The rifle is also fired in the ordinary way when quite complete, with the usual service charge of 2½ drachms. In the first proof, ten loaded barrels, with plugs, containing firing holes screwed into the breach, are laid with the hole downwards on a train of gunpowder.

The bayonets now being made for the government are the Snider, of triangular section. They are forged from a $1\frac{1}{16}$ inch round steel bar, which is drawn down under a Ryder hammer, about four inches remaining untouched to form the socket. It is next bent or "broken down," as the term is, in two places. After being cut off from the bar, sufficient metal being left for the blade, it is stamped in a pair of dies; the blade is then drawn out by the Ryder hammer. The rolling is a very interesting operation, and is performed by Barnes' patent rolling machines, in which there are two horizontal spindles, each carrying four cams, in which the dies are fixed. These cams occupy about one third of a circle; and the dies, which are cut on the periphery, are set so as to give the required thickness to the bayonet blade. After the bayonet has been trimmed, it is hardened and ground. The socket is next drilled and milled, the slot for forming the attachment to the rifle being afterwards cut; and after the further operation of "blueing" and polishing, the bayonet is complete.

MANUFACTURE OF STEEL PENS.

GILLOTT'S pen manufactory is one of the most interesting places that we visited in Birmingham, and we were highly pleased with every thing we saw, as well as with the ready civility we met there. The workers are almost all women, who amount altogether to about four hundred. The men and boys form the minority, and work in the primary departments—in other words, they do the rough work. The order and discipline maintained throughout the factory are perfect, whilst the neatness and cleanliness both of the workers and the working rooms keep pace with the commendable character of the whole establishment.

The working rooms are very spacious, and are connected with each other. The first department, in which only men and boys work, prepares the sheets of steel required. These are made to certain lengths, measuring from two to four inches in width, according to the various sorts of pens manufactured. I need not mention the thickness of the sheets, as it is easily seen from the steel pens now in constant use. When the different sheets are prepared they are handed to the stamping department, where the first and subsequent processes of pen-making are gone through. There are altogether twenty-four processes; every single pen has to go through them all before it is completed and fit for use. Each worker has a separate table, with the stamping machine on it, and a stool to herself. I should say that nearly all the processes are done by stamping. When stamped out, the pen, any kind whatever, is at first perfectly flat. The sheet used is rolled and placed on the ground on one side of the table; the worker takes hold of the unrolled end and passes it at regular intervals beneath the stamper on the block, and by the help of a contrivance worked by the feet, or by a motion of the handle, the stamper descends with a sharp rap and rises up again immediately. With great rapidity the pens are removed from the block, and the sheet pushed on. To describe the process in fewer words, I may say that it is similar to that of the stamping of seals on paper, with the exception that in the case of pen-making the stamper is made sharp so as to cut through the steel sheet placed on the matrix. The subsequent processes, such as rounding the pens, putting on the name and number, splitting the nibs, are all executed by stamping machines, nearly in the same manner as the first process. In every case only one single pen is done at a time.

The last process is the tempering, and is the most important; for through all the various stages up to the twenty-third process the pen remains in a brittle state, and hence it is unfit for use until it is tempered. The pens (one sort at a time) are put into a large pan placed within a heating apparatus—a large copper cylinder—but not directly above the fire; and by an ingenious process they are kept constantly stirring and shifting about, so that an equal degree of heat is imparted to each single one. This process goes on for a short time, and, when ended, the hot pens are scattered on the floor to cool, which being done the entire work is completed, and the manufactured articles are ready for use.

The process of making boxes for the pens is also very interesting. The makers have a great number of solid pieces of wood made in the shape of the required boxes, and about the same size. The paper used for the purpose is cut in long strips of two different widths, to suit the top and bottom and the sides respectively. The strips are then pasted on the box all round, but so managed that the end of one piece—after it has been bent to fit the corners—should overlap the other. By this process the paste does not touch the box, and therefore the paper does not stick to it. When sufficiently dry the sides of the boxes are cut a little above the middle, or about one third the depth from the top. The paper box is then in two pieces, and a thin piece similar to the shape of the box, but without top or bottom sides, is inserted in and pasted for the lid to slide upon. Thus the process of making the boxes is completed.

I must not forget to mention the making of the holders. The machinery is really wonderful. The wood is first cut into certain sizes and lengths, and then inserted into a machine which planes and rounds them. Several sorts of holders are made, and, therefore, each sort has a separate machine. I shall speak only of the ordinary short holders. These, when rounded and cut, are generally put into another machine to be pressed. This process gives the holders the uneven impression or the grooved marks in order that they may be more easily held. After this they go through the process of rounding and thinning the ends—that is, one end is rounded and the other pressed smaller to allow the putting on of the case in which the pen is inserted. The holders are put in great numbers into the opening of the machine, which is so constructed that only one holder can go through at a time, and when this one is finished it drops into a box beneath, while the one immediately above it takes its place; and the same process continues. This is the last process of holder-making. There are also a number of women employed in putting the pens into boxes. The pens are all counted, and the name of the manufacturer, with the description of the pens on printed paper, is pasted on.

OCEAN STEAMERS.

THE lengthening of iron steamers has been overdone. The ocean steamship of the day, with some exceptions, is like the two towns in France, "too long and too loose;" and there are other objections in the details of construction and rig which must in time be remedied. The *safety steamer* should be built with a double bottom up to the load water-line; and the deck over this part (excepting where the motive power comes) should be of iron divided into water-tight compartments, and the hatches should be made to secure like man-holes, perfectly tight. Each compartment should be supplied with its own pumps, to be worked by power *wholly distinct from the main engines and boilers*; and besides the steam pump, each compartment should have a hand-power pump, so that, under certain circumstances, the steerage passengers may be utilized to keep the ship afloat. Each compartment should be laden with cargo suited to the locality—that is to say, the heavy goods should be stowed amidships, and the lighter goods in the fine ends. This distribution of cargo (as every careful stevedore knows) must add much to the security of the ship. It not unfrequently occurs that steamers go to sea out of trim, dangerously deep, and badly loaded, trusting to making all right by the consumption of coal in two or three days.

The engine room of a steamer should be *wholly cut off from the boiler room* or stoke hole, and should have iron bulkheads running up to the spar deck, and it should have pumps and fire apparatus for keeping that part of the ship clear of water—so arranged, in short, that if the ship be stove in that part, and leak beyond the control of the pumps, the water shall be confined to that section of the ship. There should be no bulkhead doors whatever, and no communication, except by pipes or speaking-tubes, with the stoke hole.

We will suppose that in a steamer 400 feet long the motive power occupies about 80 feet fore and aft—say, 30 for the engines and 25 each for two boiler spaces; one of these should be before and one abaft the engines, and the bulkheads of these spaces, like those of the engine room, should run up to the main deck amidships, leaving space in the wings for communication, so that any fire in a stoke hole should not immediately be communicated to the vulnerable parts of the ship. The principal coal bunkers should be immediately before and abaft the boiler spaces, and should be so arranged that a considerable portion of the coal be stowed above the load line, and thus be carried to the stoke holes by its own gravitation. The coal stowed below the load water-line should be taken up by some kind of drum or elevator or conductor moved by steam power and dumped into shoots or spouts leading to the stoke holes. *No communication whatever to be permitted between the coal bunkers and the boiler rooms below the load water-line*, and each boiler room and each coal hole to have its own pumps, to be operated by donkey engines, and boiler wholly distinct from and out of the way of the main engines. The coal on its way to the stoke room should be sprinkled with water to keep down the grit and dust; this is most important where anthracite coal is used.

My general idea as to feeding the furnaces is to have a drum hung on trunnions, of large diameter, into the compartments of which a certain known amount of coal may be shovelled by the lower class of coal passers, and delivered into the stoke hole just as fast as wanted, and thus a correct account of coal consumed be kept by measure, and fed to the furnaces by first-class firemen. The drum should be operated by a small engine under control of the stokers. According to my belief the great desideratum for safety is to cut off and keep distinct the engine room, the boiler spaces, and the coal holes. If not adding too much to cost, I would have all water-tight bulkheads *double to the load line*, and have means to let in water.

If the principal cargo spaces are made air-tight and water-tight, a small additional expense would furnish a hand air-pump, so that in the event of a leak in the bottom the water may be kept out by forcing air in.

All this would tend much to making an unsinkable ship a safe conveyance for passengers and freight. Having now made the ship up to the water-line and up to the main deck in the wake of engines, boilers, and coal bunkers, a series of compartments or tanks wholly disconnected from each other, I come to the accommodations for passengers. Supposing the ship to be about 400 feet long between stern and inner stern port, and that the engine boiler and coal spaces occupy 110 feet, there will be abaft the engines about 110 feet on the main and also on the next deck for saloons and cabins, and before the forward coal hole, about 96 feet on two decks for the steerage passengers, making 316 feet devoted to passengers, leaving 84 feet forward to accommodate the donkey engines, windlass and chains, seamen and firemen, stock, etc. The engineers can be accommodated in the wings near the motive power, and the officers on the upper deck, otherwise clear of obstructions fore and aft, excepting always the steering geer aft and forward, the lighthouses, boats, rafts, and life-saving gear. There must be means for passing along the sides on one deck through the bulkheads. These side passages should run fore and aft so far as the shape of the ship will allow, and be entirely under the control of the officers and stewards, so that the side ports may be kept open or closed according to the state of the weather, and they should be so arranged as to give light and air to saloons running entirely across the ship, and to state-rooms entirely distinct from saloons.

I hold that the usual plan of carrying the state-rooms out to the side is all wrong. The side ports on the main deck are generally, if not always, kept closed at sea, and those on the next deck when allowed to be open are exposed to rain and washing decks, and are often closed obtrusively when they might be open. My plan is to have a passage-way all along the sides of the two decks devoted to passengers and officers, so that the watch may go round at all times, open and close ports without disturbing the passengers who occupy rooms. Any water coming into these ports will do no harm, and will be carried off by appropriate scuppers instead of invading the rooms. In a ship of 42 feet beam there will be room for two passages, each 2½ feet wide, a passage amidships of 3½, and four rooms, each 8 feet wide, leaving 1½ for the frame and lining. 110 feet fore and aft for the first-class rooms would give 40 rooms 11 feet by 8 on each deck, or a total of 80, large enough to stow three persons. Besides this space of 110 feet there will be room on two decks for saloons running across the ship, 32 feet fore and aft, large enough for dining-rooms. The centre rooms can be lighted and ventilated by skylights broad enough to light the centre gangway as well as the rooms.

The details of accommodations, when we come to making a plan, may require concessions for gangways, pantries, smoking-room, etc. I give the above general idea of accommodations more to call attention to utilizing light and air by side passages than with any idea of accurately laying out the same. I can not leave the subject without a word on the rig of ocean steamships. These I would divide into two classes: one making the short Atlantic trip in eight or ten days, and one for the China, Japan, Brazil, and other routes requiring longer time.

For the short Atlantic route, *if I could be sure of never breaking down*, I would cut my spars down to mere jury masts and have no square yards to keep me back; but as we must always be subject to breaking down of machinery, loss of screw, or coming short of coal, it is necessary to have means for taking care of the ship by canvas. To this end I would have one mast square-rigged, and two or more fore and aft rig, with a spare set of yards and sails for one other mast to be rigged in case of necessity.

The Pacific route, the Brazil route, and the route to India and Australia by the Suez Canal, require more canvas, as there are many places where it can be used to save time and fuel; one mast for this class should be rigged with square yards of ample proportions, and three others fore and aft rigged also, of larger proportions than for the Atlantic. In the latter each mast may be of iron and in one piece; in the other routes the lower masts may be of iron, and the pole upper masts of wood, fitted to house easily; the double top-sail now so commonly used should be adopted in all ships having square yards, and all fore and aft sails, excepting only the mizzen, should be *stay-sails and not gaff-sails*. The limits of this paper will not permit me to give details as to the proportions of yards and sails, but as a general rule they should be such as to require little or no reefing. The absence of well-trained seamen, which is the rule in steamships, renders it important to have the canvas divided into small proportions, and the occurrence of very severe cyclones, even in the Pacific Ocean, renders it important to have very stout canvas and some exceptionally small storm-sails.

In the course of my experience as an owner of ships, and a contriver of new rigs, I have found that many of my original suggestions, although unpopular when made, have gradually come into use. The double top-sail, for instance, first put on my vessels in 1844, '45, and '46, was for a long time looked upon as an innovation of little merit; now it is the rig used all over the world by all nations. The fidding of the pole masts carrying the two square sails above the lower cap, abaft the masthead, is an important matter in steamers, and in ships of war, where to make snug easily going head to wind is sometimes very important; yet it has not, like the double top-sail, been extensively adopted. The navy has been particularly backward in adopting labor-saving devices, and especially new rigs. The experience of our ships of war in blockading at anchor in exposed places should have taught our naval architects and seamen to adopt the double top-sail, which rig, with pole topmasts fidded abaft, enables a ship to house all her top hamper, and yet leaves her in condition to get under sail equal to double-reefed top-sails and courses, jib and spanker, at short notice. For a long time the navy ignored iron trusses, iron rigging, iron gun carriages, and high-pressure compound engines; now all these are becoming common, and it requires but a step further for them to adopt the double top-sail. The usual argument with naval men is that they "do not require labor-saving processes, because they have plenty of men;" and yet we see them everywhere hampered by powerful contrivances to assist the men, which are not found necessary in the merchant service. According to my experience, a vessel of war in war time requires labor-saving machinery more than any other; so that by manning prizes, by details of men sent out of the ship, and by the casualties of war, she may not be disabled. I should like to add something as to manning the navy, and as to the education of youth for seamen by the Government, but the limits of my paper prevent. I am, very faithfully, yours,

R. B. FORBES.

MILTON, October 21st, 1876.

RECENTLY Messrs. John Brown & Co., of Sheffield, have successfully rolled an armor plate which is twenty-four inches in thickness. When the rough ends were sawn off, it was found that the vast mass was perfectly sound and without a flaw. This plate is thicker than any which has yet been rolled, and is believed to be invulnerable to the heaviest artillery. It is not improbable that even thicker armor plates than this will yet be turned out by the same firm.

STEAM RIVETED BOILER.

AN improved boiler 30 ft. long and 7 ft. diameter has been completed by the Turnbridge Iron and Boiler Works Company, established about two years since, and upon being tested has given great satisfaction. The boiler has been constructed upon the most approved principles, and in its formation great care has been taken to derive the greatest benefit from all the newest inventions. The boiler being designed for high pressure, or to bear a pressure of about 100 lbs., plates of $\frac{5}{16}$ instead of $\frac{7}{16}$, as generally in service in mill boilers, have been used. Another improvement has also been made in cutting and in the working of the plates. Instead of having the rough edges usually noticeable in boilers, each plate is cut, bent, or turned, and planed with machines, thus ensuring uniformity and strength. A great feature in the construction of boilers by the company is the evenness to be noticed in the welding together of the huge plates, caused by the metal having been well planed, and the manner in which the massive sheets of iron are riveted. Instead of riveting by hand, the company have in operation a steam-hammer of 25 tons power, which affixes a rivet at a single blow. The advantages of a machine for such a work are very palpable. In working the rivets by hand it may easily occur that one rivet receives quite double, or possibly treble, the attention in working over another, but in the case of a machine the power is always uniform and just.

EXPLOSION OF AN IRON FURNACE.

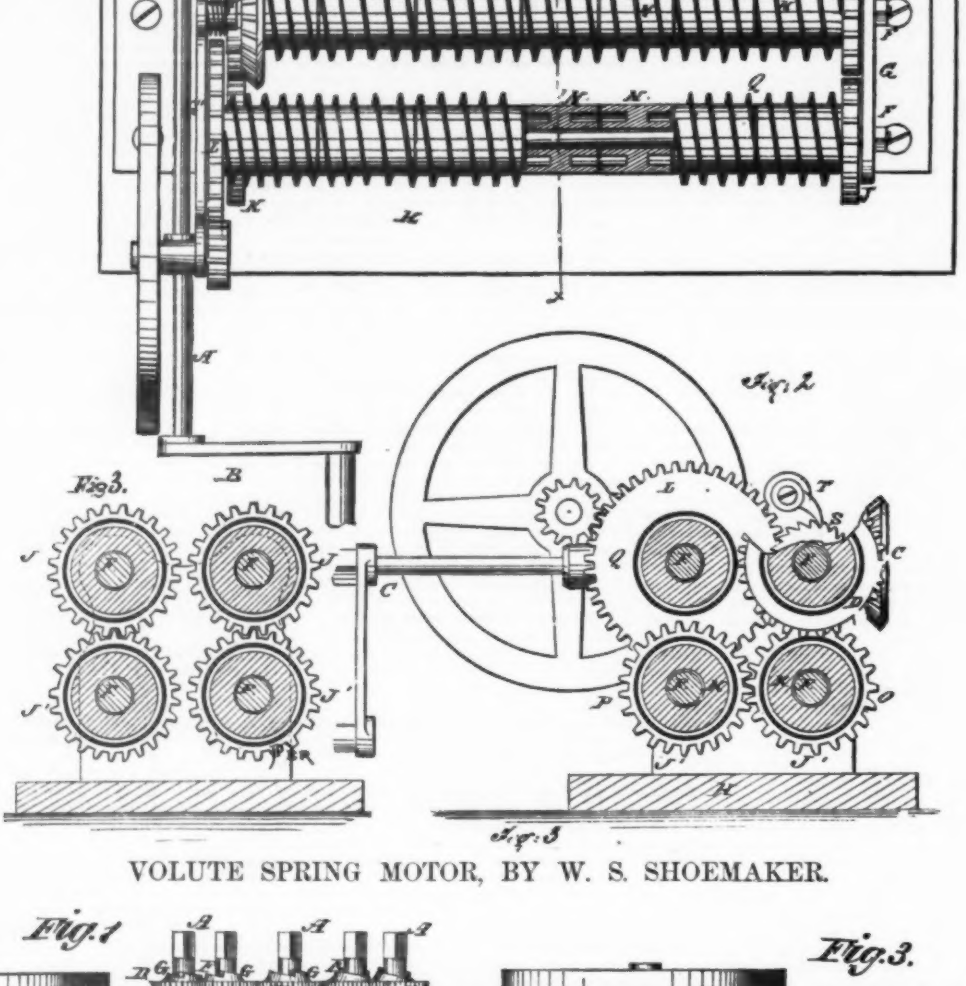
A FRIGHTFUL explosion recently occurred at Ditton Ironworks, near Widnes, by which seven persons lost their lives. The works consist of blasting-furnaces, of which there are several. The centre furnace contained about twelve or fourteen tons of molten metal ready for manufacturing into pig iron, and ten minutes before the explosion took place the foreman and furnace inspector had walked round the furnace and found every thing apparently all right. Three men were at work in the vicinity of the furnace, while about forty yards in front of it were seated several men comfortably enjoying their morning meal. While the men were thus quietly refreshing themselves, without the slightest indication a loud explosion was heard, and in a moment, with the rapidity of lightning, from the cupola shot forth a huge volume of flame, consuming every thing within its reach. Accompanying it, like a volcanic eruption, came molten metal, coke and ashes, all of a white heat, the destructive elements covering the unfortunate persons who were in front of the furnace. To three persons death was instantaneous, one of them being a little girl, aged ten years, who had brought her father's breakfast, and who was at the time of the accident playing with the sand. The other two were a man aged sixty and a youth of eighteen, who were working near the furnace. Four other persons have succumbed to the effects of the explosion. It blew down some stacks of pig iron fifty yards distant, and carried some of the bars into an adjoining field some one hundred yards away from the scene of the explosion. Even the men's clog irons were burned off, and so severe had been the heat that in some cases the bodies themselves were literally consumed, hardly any trace of identification remaining.

SUBSTITUTES FOR HORSES ON STREET CARS.

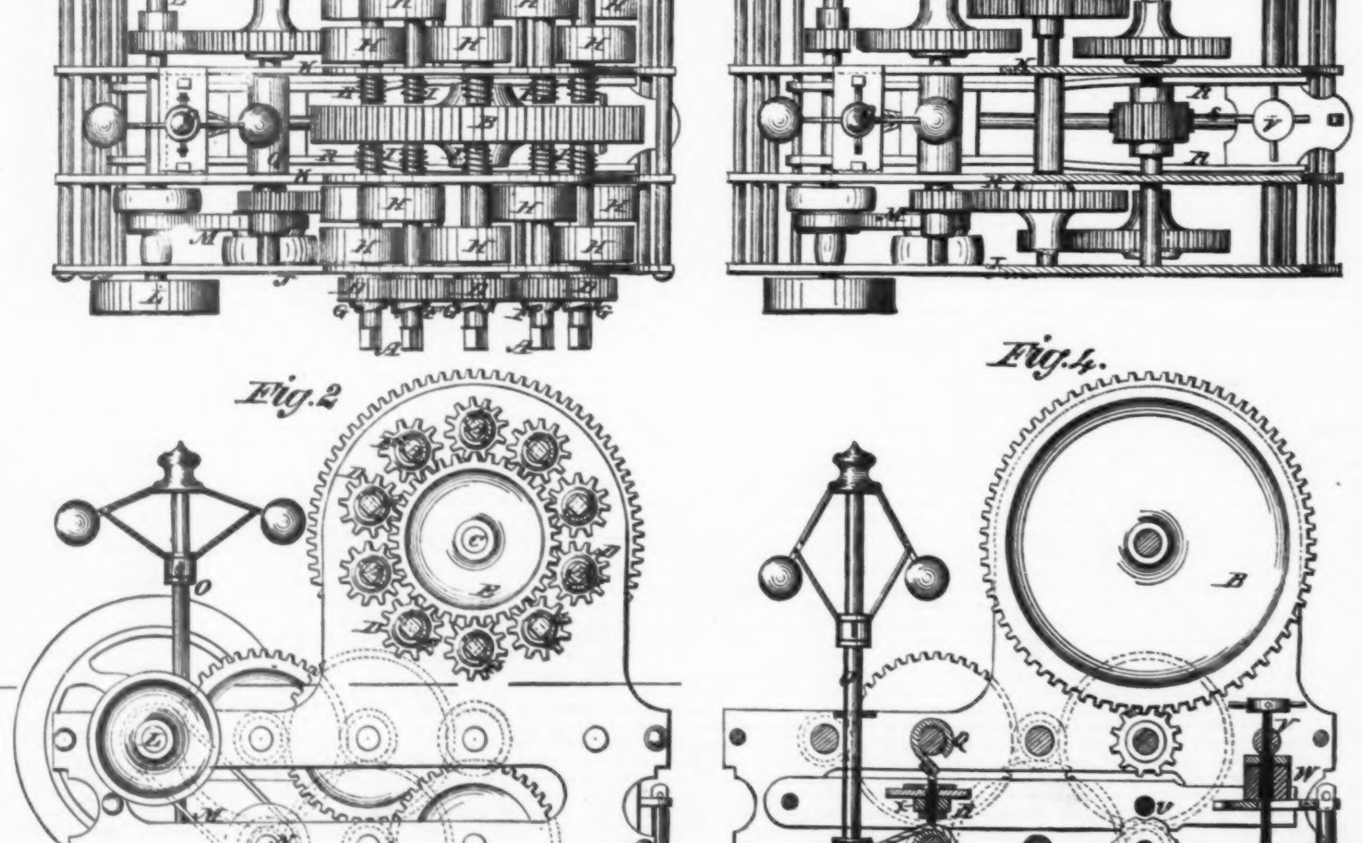
A MOST interesting series of experiments instituted by the Vale of Clyde Tramway Company were lately carried on on the line between Glasgow and Govan, Scotland. This enterprising Tramway Company applied for and obtained in the last session of Parliament the necessary authority to substitute mechanical instead of horse-power to their cars. Since that time they have been engaged in testing the various patents now before the public aiming at this end. The principal of these patents are the steam tram-car engine constructed by Messrs. Merryweather & Sons, Lambeth and Long Acre, London; the steam tram-car engine of Messrs. Henry Hughes & Co., Loughborough; and the by this time tolerably well-known pneumatic tramway-car patented by Mr. Scott-Moncrieff, of Glasgow. Each of these has been tested on the line of tramways between Paisley Road Toll and the Govan terminus. Arrangements were made for seeing the three patents in practical work together, in presence of the Provost and Commissioners of the Burgh of Govan. The engines both of Hughes and Merryweather have this in common, that they are entirely separate from the passenger car, being enclosed in a car the external appearance of which has nothing of the steam-engine about it, and which may be coupled from either end to the passenger car. The special feature of Messrs. Hughes's engine, which started on its journey first, is that it is supplied with ample coke and steam before starting to last the whole run, so that the driver is enabled to give an undivided attention to the traffic before him. It is also built with a view to taking steep gradients, the engine exhibited by the firm in Leicester taking a gradient of one in twenty-two with ease. Messrs. Merryweather's engine is much lighter in build and smaller in compass, but the driver, in addition to attending to the brakes and the signals of the conductor, has to stoke occasionally. However, Merryweather's patent has stood the test of practical work, engines by this firm having been employed on the Paris tramways for the past nine months, while others are in present use at Vienna, Ryde and Wantage. It is also claimed for the patent that it may be applied to an ordinary car in such a manner as to make it a complete locomotive in itself. The experiments were of a very satisfactory character, both engines showing great power of draught and good speed, and being thoroughly under the control of the driver.

TRIAL OF A COMPRESSED-AIR CAR.

After these had completed the journey from Govan to the Paisley Road Toll and back, Mr. Scott-Moncrieff exhibited the power of his compressed-air engine. In this case the car is complete, the reservoirs of compressed air and the cylinders being fixed in a framework beneath the flooring. Beyond a little puffing noise at starting, the air engine did its work admirably, and was evidently viewed with great satisfaction. The other engines were noiseless, and in the case of Hughes's patent smokeless, so that no inconvenience was experienced by the outside passengers. Speaking generally, the trials were of the most successful character, and gave full proof of the practicability of substituting steam or other power for that of horses. It is said that the representatives from the Edinburgh Tramway Company were so impressed with the success of the experiments that it is very probable that company will make application in the next session of Parliament for powers similar to those enjoyed by the Vale of Clyde Tramway Company.



VOLUTE SPRING MOTOR, BY W. S. SHOEMAKER.



SPRING MOTIVE POWER, BY FRAHM AND SCHARNWEBER.

VOLUTE-SPRING MOTOR.

By W. S. Shoemaker, Baltimore, Md.

One end of the spring is connected to a shaft, by means of which the said spring is compressed or wound up, and which shaft, in the uncoiling of the said spring, is turned, and thereby transmits motion, through the medium of suitable gearing, to a second shaft, adapted to do useful work. The other end of the spring is attached to a drum or casing of the spring, which is fitted with gearing, also operating upon the working shaft, to influence it in the direction which it takes through the medium of the gearing aforesaid.

A the spring, and B its casing, to which is secured the gear wheel C, adapted to engage with the pinion C' keyed to the shaft D. The outer end of the spring A is fastened to either the casing B or to the gear-wheel C, and, through these wheels, transmits movement to the shaft D aforesaid. The inner end of the spring A is connected to the shaft E, which has the toothed wheel F running loosely thereon but adapted to have a movement in one direction, in common with the said shaft E, by means of a ratchet-wheel, *a*, and pawl *b*. The movement of the wheel F is also transmitted to the shaft D, but through the medium of the idler-wheel G, which engages with the wheel H keyed to the shaft D.

It will be seen that, upon the spring being wound up, both ends thereof communicate motion, in a common direction, to the shaft D, which may be used as the prime mover of mechanism designed for various purposes.

Applicable to all the uses for which volute-spring motors are employed, the advantages consisting in that the entire elastic force inherent in the spring is utilized in revolving the main shaft D.

May be applied to cars, in which case the springs are wound by steam power as mentioned in Supplement, No. 47.

SPRING MOTOR.

By Charles M. Frahm and William Scharnweber, Chicago, Ill.

This invention is a contrivance of the arrangement of a series of coiled springs and gears, whereby a large number can be arranged in a small space, and each spring can be wound up independently of the others, and while the machine is running; and the invention also comprises a simple arrangement of regulating apparatus and stop mechanism, all as hereinafter described.

Fig. 1 is a plan view, Fig. 2 is a side elevation, Fig. 3 is a horizontal section, and Fig. 4 is a longitudinal section of the improved machine.

A represents a couple of series of spindles on opposite sides of the main driving-wheel B, and arranged around its axis C, each spindle having a pinion, D, gearing with a wheel, E, on said axis. The pinions are loose on the spindles, and clutch on pins F, by their notched hubs G, which are spirally cut, so that the spindles will turn independently of the pinions for winding up the springs H, one of which is mounted on each spindle. The spindles slide a little endwise to allow the clutch-pins to pass over the notched hubs of the pinions, and the spiral spring I draws them back. The spring-spindles are arranged in the housing frames J K, which are placed far enough apart to allow the alternate arrangement of the springs of each series in two different planes, so that the spindles can be arranged closer together, and more springs can be arranged in one series around a wheel, E, of a given size than can be in one plane. The motion is transmitted to the pulley-shaft L by a suitable train of gears, to be transmitted therefrom in any approved way to the machine to be driven. From the pulley-shaft a belt, M, is run to the shaft N for working a governor, O, which is to regulate the speed by the friction-brake, Q, which it works by the levers R and S. The machine is stopped by the notched wheel T, rod *e*, and the screw V, the screw being turned, so as to press the rod *e*, which is on the brake-levers R, down into the notches of the wheel, which is geared indirectly with the main driver B, so as to stop the machine. W is a spring by which the screw V is connected to the brake-levers, to afford relief to them in case the rod *e* is screwed down on the face of the stop-wheel.

There is also a spring, X, on the rod connecting brake Q with the levers R, to afford easy action. Two or more springs may be arranged on each spindle, provided the length of the spindle is increased.

The machine is designed for operating sewing-machines, lathes, churns, and any other machines for which a light power is required, and, if desired, it can be made large and strong for heavier work, such as cars and carriages.

IMPROVED SPRING MOTOR.

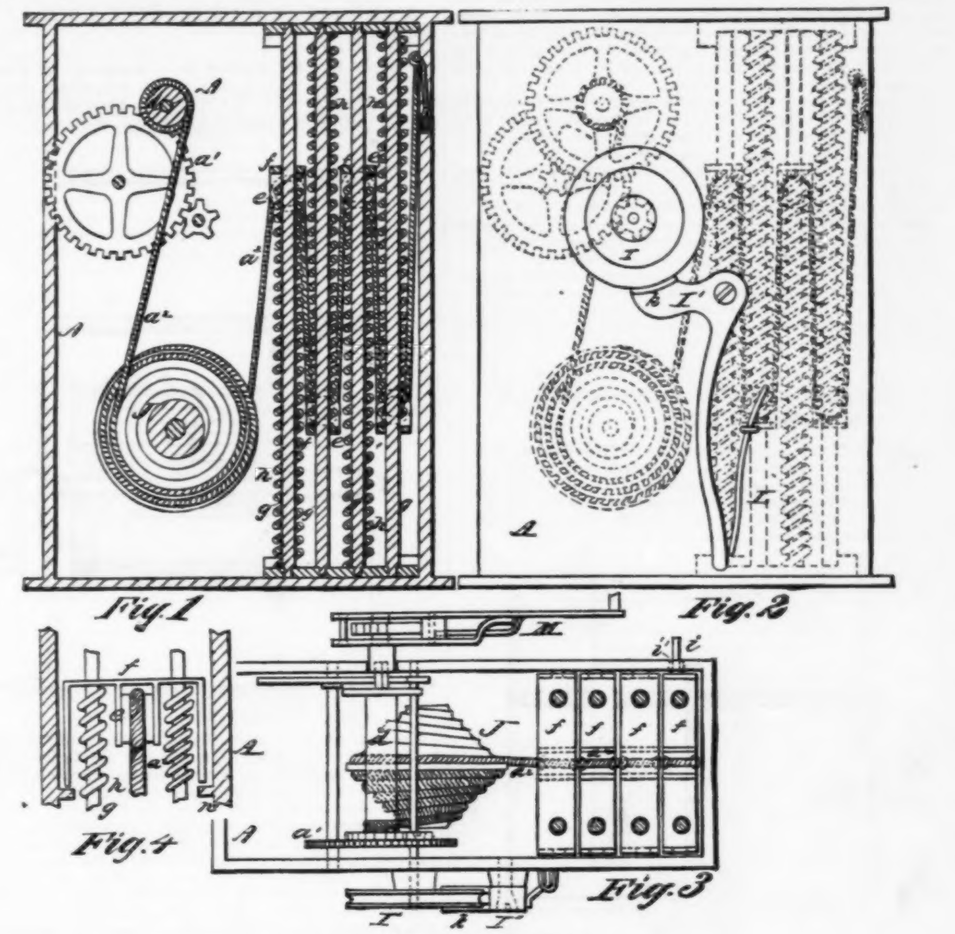
By J. W. H. Doubler, Philadelphia, Pa.

A, box containing the working parts of the motor. B winding-shaft, through which motion is transmitted to the power-shaft *a* by gearing a^1. This motion is obtained from a set of spiral springs, through cord a^2, passing around a fusee, which compensates for the variation in the tension of the springs under different degrees of contraction and expansion. From said fusee the cord passes in one direction to a drum, on the winding-shaft B, and, in the other direction, is carried alternately over and under a series of pulleys *e e*, etc., attached to plates *f f*, which slide upon upright rods *g g*, around which are wound the spiral springs *h h*, etc., arranged in pairs, bearing alternately upon the upper and lower surfaces of said plates. The end of the cord is fastened to the frame of the motor.

In winding up the apparatus the springs are merely compressed in the direction of their length by the movement of the plates upon the rods, the plates travelling alternately upward and downward, or all toward a central point, in consequence of the shortening of the cord. As the springs expand the plates separate, lengthening the cord and unwinding the same from the drum on windng-shaft. The motion so imparted to the latter is communicated by the gearing to the power-shaft.

The duration of the motion resulting from the expansion of the springs depends upon their length and number. Their successive numbers and length do not, however, in any degree influence the amount of power, the latter being dependent upon the individual character, or that which is the equivalent, the number of springs taken to complete each set of the series, the same being a matter of discretion.

The completion of the contraction of the springs is externally indicated by means of a pointer *i* projecting from one of the sliding plates through a slot *i'*, in the back of the cabinet, as shown. The fusee J is of a peculiar character, diminishing toward both ends from the middle part or greatest diameter, as shown. The cord from the spring-pulleys to the drum unwinds from one end of the fusee toward the greatest diameter, and on the other side winds from the greatest diameter toward the opposite end. Thus, according as the tension of the springs increases by their contraction, the leverage of the fusee increases so as to compensate for said increase of tension. The same compensation occurs in a reverse direction, as the springs expand the wound portion of the cord unwinding, and the balance winding upon the fusee. I designates a fly or belt wheel upon the end of the power-shaft, and I' a brake-lever, having a cushion *k* of rubber or



DOUBLER'S SPRING MOTOR.

other suitable material on its short arm, which, being pressed against the periphery of the wheel I, either regulates its speed or arrests its rotation altogether, according to the degree of pressure. A spring L, bearing against the end of the long arm of said lever, serves ordinarily to keep the cushion from contact with the wheel. M designates a winding-key, having a ratchet and pawl applied to a pivoted handle, so that the stem of the key can be turned in one direction only, thus allowing the handle to be drawn back after each half revolution. *n n* are stops to arrest the movement of the sliding plates and prevent their over-contraction.

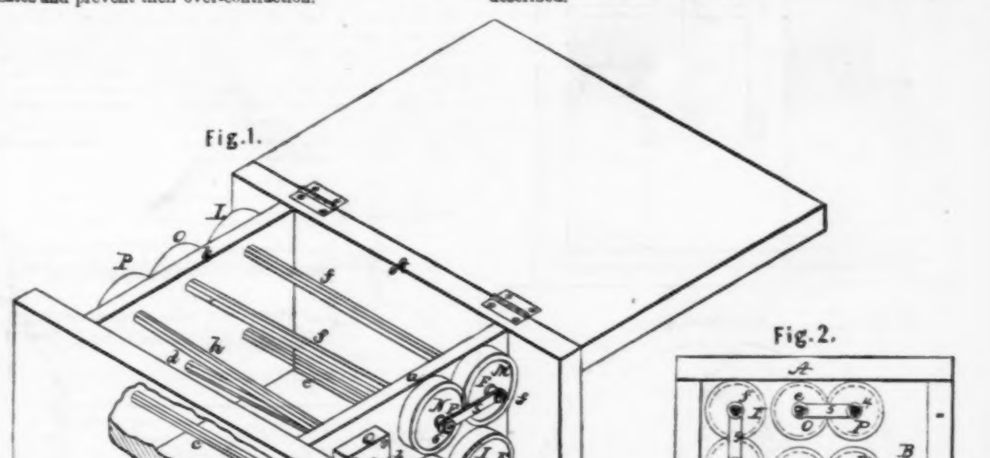
TORSION-SPRING MOTIVE-POWER.

By Albert M. Bacon, Boston, Mass.

Consists in a series of torsion wires or bars, so arranged and provided with gearing that they may be twisted, to form a spring, the tension or power of which will correspond to the degree of twist given to the bars.

A box or frame-work, across the interior, and through the parallel sides *a b* of which passes a shaft B, having secured, at one of its ends, a cog-wheel C, which drives a similar cog-wheel D, into and through which pass the ends of a series of three bars or wires *c* of tempered steel, which extend through the side *a* and across the interior of the frame-work, and through the side *b*, where their opposite ends are firmly secured to a gear E, similar to those C D, both ends of the series of wires passing through their respective wheels, and having collars F slipped over them, for the reception of couplings or links 5, in order to prevent the separation of the wheels C D (intended to engage with each other), and for keeping the wheel E in gear with a similar wheel G on the extremities of a series of three wires *d* (similar to the series *c*) passing through the interior of the box or frame-work and at a short distance from the series *c*.

H is another similar gear (secured to the opposite ends of the wires of the series *d*), which meshes into a corresponding wheel I, through which pass the ends of another series of wires *e* extending across the box, the wheels H and I being kept in gear by a coupling or link 5 similar to that already described.



BACON'S TORSION-SPRING MOTOR.

The extremities of the series *e* of wires opposite to those secured to the wheel I are firmly secured to a gear K, similar to those previously described, which is coupled with and drives a corresponding gear L, on the extremities of another series *f* of wires, passing through the sides *a b*, and across the frame-work.

M is a cog-wheel, to which are secured the opposite ends of the series *f* of wires, the wheel M engaging with and driv-

ing a corresponding gear N secured to another series *g* of wires, to the opposite ends of which is also secured a gear O, which, in its turn, is coupled with and drives a gear P, secured to the ends of another series *h* of wires, the opposite ends of this last series being rigidly fastened to a block Q, attached to the side of the frame-work.

The several wheels, C, D, E, G, H, I, K, L, M, N, O, and P, are provided with holes, for the reception of the ends of the wires, as seen in Fig. 3, by which construction, when power is applied, by crank or otherwise, to revolve the shaft B, the several gears are caused to turn, and each wire of each series is twisted around the remaining two wires of its series, and a spring of great tension is thus produced, the degree and duration of the power being determined by the number of wires or series of wires employed, and the number of revolutions given the shaft B.

In practice, I intend to employ wires or bars from six to twenty feet in length, and to place a large number of them close together, within a suitable box or frame-work, thereby multiplying the power to the required amount.

If preferred, instead of a series of three wires, a single wire, with its ends securely fastened to the cog-wheels (so as to prevent it from turning independently therein), or two or more wires, may be employed; and instead of the wire or wires being circular in cross-section, they may be square, without departing from the spirit of my invention.

By means of the construction above described, any amount of power may be created, and its expenditure regulated by suitable mechanism, so that it may be applied in propelling street-carriages, velocipedes, railway-cars, boats, etc., or for driving machinery in buildings.

MOESLEIN'S PLAN FOR SPRING MOTOR.

By Valentine Moeslein, Waterloo, Ill.

This is a contrivance of double but independent springs in a spring-power apparatus, so that both work together to drive one and the same train, and each can be wound up independent of the other, whereby one may be wound up when the other is partly run out, and *vice versa*, making a regular and uniform continuous power.

Fig. 1

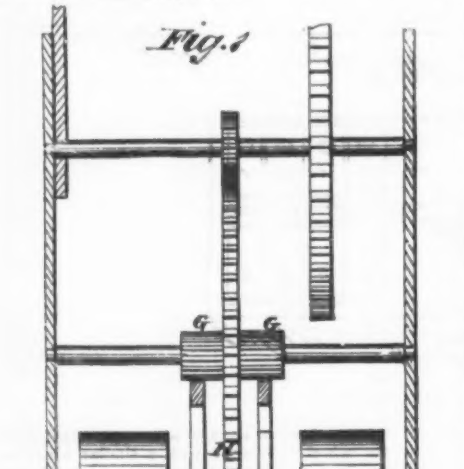
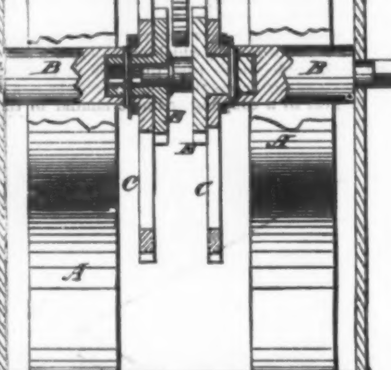


Fig. 2.



MOESLEIN'S SPRING MOTOR.

A, the spring; B, the shaft; C, the driving wheel; E, the ratchet, and F the pawl of each apparatus, both being arranged in the same axis, with the wheels C fronting each other, a little distant apart, so that both may gear with the pinion G of the transmitting train on opposite sides of the master wheel H. The two spring shafts are connected by a stud, I, of one entering a socket of the other, and forming a coupling which allows one to be turned independently of the other.

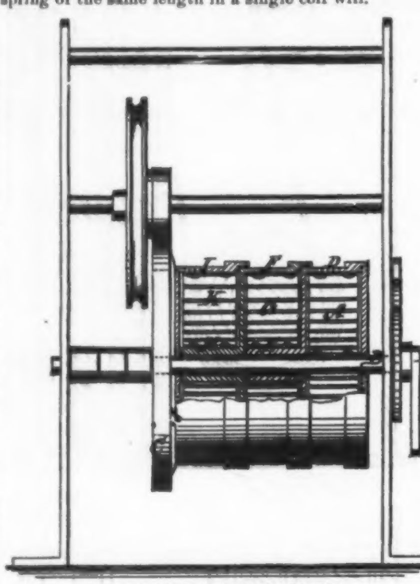
This motor may be applied to the driving of cars, carriages, sewing-machines, churns, etc. The number of springs and the extent of the power may therefore be increased *ad libitum*.

When applied to the propulsion of street cars, the springs are intended to be wound by steam power, as described in Supplement, No. 47.

SPRING MOTIVE-POWER.

By John B. Howell, Wilkesbarre, Pa.

Consists of a series of coiled springs and cases or drums therefor, arranged side by side on a shaft, and combined together and with the winding-up mechanism and transmitting mechanism in such manner as to constitute in effect one spring of great length but in separate coils, which, the author thinks, gives much better results in practice than a single spring of the same length in a single coil will.



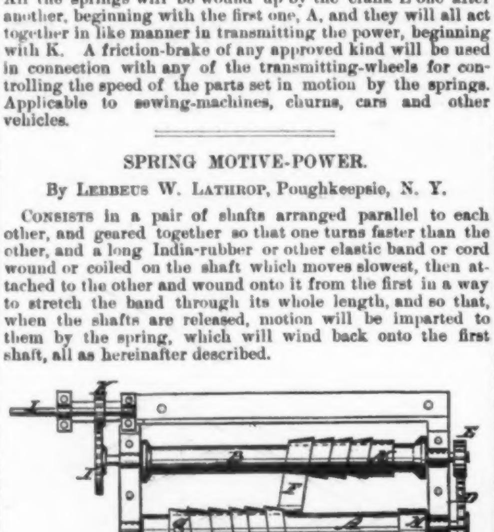
HOWELL'S SPRING MOTOR.

The first spring A is attached at the inner end of the coil to the winding-up shaft B, which also serves for mounting the spring-drums or cases and the transmitting-wheel C. At the outer end of said coil this spring A is attached to the hollow drum or case D mounted loosely on the shaft. This drum has a central hub, E, extending along the shaft B within the second drum F, and the spring G in said drum is attached to said hub at its inner end, the outer end being attached to the drum F. This drum F also has a hub H, extending into drum I, and the spring K therein is attached to it and to the drum as the others are. This arrangement may be extended with as many springs and drums as required, but in this example the drum I is attached to the transmitting-wheel C. All the springs will be wound up by the crank L one after another, beginning with the first one, A, and they will all act together in like manner in transmitting the power, beginning with K. A friction-brake of any approved kind will be used in connection with any of the transmitting-wheels for controlling the speed of the parts set in motion by the springs. Applicable to sewing-machines, churns, cars and other vehicles.

SPRING MOTIVE-POWER.

By Lebbeus W. Lathrop, Poughkeepsie, N. Y.

Consists in a pair of shafts arranged parallel to each other, and geared together so that one turns faster than the other, and a long India-rubber or other elastic band or cord wound or coiled on the shaft which moves slowest, then attached to the other and wound onto it from the first in a way to stretch the band through its whole length, and so that, when the shafts are released, motion will be imparted to them by the spring, which will wind back onto the first shaft, all as hereinafter described.



LATHROP'S SPRING MOTOR.

A is one of the said shafts and B the other. They are arranged on any suitable frame C, and geared together at one end by the large wheel D and the small one E.

F is the India-rubber belt, or it may be a round cord. It is fastened at G to the shaft, and wound or coiled spirally thereon, as shown, the coil extending from end to end of the shaft, or nearly so; then the other end is attached to the shaft D at H, and, the shafts being turned by hand, for which a hand-crank or other means is to be provided, the belt will be wound off from A and onto B, and at the same time stretched as much as is due to the difference in speed of the shafts. As the shafts revolve in opposite directions, the band winds from the top of one to the bottom of the other.

The band or cord thus stretched will, of course, have a tendency to turn the shafts back again, and wind back from shaft B to A, the same being in the same measure as the power expended in stretching the belt, and a part of this force may be utilized in any of the known ways in driving other machines which may be geared to the shafts in any preferred way, for instance, by the wheels I K and the shaft L.

The motion, which when unrestrained will be very rapid, may be regulated by a friction-strap M, lever N, and a spring O, or by an escapement and pendulum, or any other suitable means, as preferred.

ON THE PROGRESS OF AERONAUTICS.

By Fred. W. Brearey, Hon. Sec. to the Aeronautical Society of Great Britain.

To the casual observer of a balloon which floats away from his presence into the dim distance, amidst the cheers of the crowd, and from thence into the solitude of an infinite space, it is hard to believe that its utility is doomed to the limit of mere flotation. He thinks that there is either an immense amount of apathy or else a lamentable display of ignorance among mechanical minds which prevents their energies being concentrated upon the navigation of the balloon. This is of course the popular judgment, yet it is only partially erroneous. The late Franco-German war afforded an opportunity for energy and engineering capabilities, and we know something of what balloons are capable, though perhaps not the uttermost, especially when accompanied by unlimited expenditure. The termination of the war interfered with certain designs, for the accomplishment of which M. de Fonvielle had escaped from Paris in a balloon. As he was the chief of the Aeronautical Department, he hoped to collect at Lille all the balloons which had left the French metropolis, and he himself came to England with the object of consulting as to the best means of aiding the return journey.

When the armistice was concluded six balloons had been collected at Lille, waiting for a favorable wind. By the aid of a small propelling force M. de Fonvielle believed that, starting with a fair wind, he would be able to deviate a few degrees from the current if necessary. It is highly probable that the return would have been effected, as Paris was the centre of a circle of investment of twenty miles diameter. With a favorable wind a sailor named Gally, with three others, left Paris on November 12, with the intention of reaching Bordeaux, and they descended at Gondreville, *near* Bordeaux.

There is an anomalous incidence connected with the subject which would seem to favor the advocates of balloon propulsion, viz., that although water is about 800 times denser than air, yet the rarer atmosphere is capable of supporting the heavy bird, whilst the fish is about the same density as the element which it inhabits. They forget, however, that the currents to which the denser elements are liable, and with which the fish can cope with ease, are limited to eight, or at most to ten miles an hour, but where might the balloon be in a similar period? Possibly eighty miles away. Let us suppose a boat under the same conditions as often appertains to a balloon, viz., in a current of twenty miles an hour. The river, let us say, is five miles across, and we can propel our boat at the rate of five miles an hour, as M. Dupuy de Lome has lately accomplished in France with a balloon. The boat is accordingly propelled to the other side in one hour, but in that time it has drifted twenty miles down stream.

Now by powerful machinery it is just possible to propel a rigid construction like a boat against such a current with perfect impunity, but to attempt the same thing with a balloon is an abandonment of all scientific principles. Any attempt to force the balloon unnaturally into the condition of the boat must be made at the risk of a burst-up.

In the case of the boat, the thrust of the propeller is in the same line with the centre of gravity and displacement. In the case of a balloon the propeller works from a pendant car considerably below the centre of displacement.

If it were possible, therefore, to propel the balloon at a rate which bore a more suitable proportion to the force of the currents to which it is liable—let us say at the least twenty-five miles an hour—we may, without travelling with it to note the effect, just imagine the balloon anchored to the ground from the car, and a wind of twenty-five miles an hour blowing against it, which is precisely the same thing. The balloon would be forced into an inclination of about 60° out of the perpendicular.

The dimensions of a balloon intended to carry a propeller with the men or machinery to work it, could scarcely be less than 60 feet in height by 50 in breadth, and taking the mean it would be equal to a sphere whose largest section would contain about 2372 square feet. If we take two thirds of this, viz., 1581 square feet—because remember that it is a compressible sphere—we shall obtain a surface upon which the whole force of the wind at twenty-five miles an hour will be expended; and at that rate, by Rouse and Smeaton's tables, the pressure upon each square foot exposed would be 3075 lbs., equal to a total force of 4861 lbs., or upwards of two tons. We find, therefore, the pressure to which a balloon of that capacity would be exposed were a motive power furnished capable of propelling such a balloon at twenty-five miles an hour; and we learn also the angle of inclination which the car would assume relative to the balloon, the car in this case being in advance. Of course a more suitable shape of the balloon would modify these conditions, but only to produce other elements of difficulty which can not be overcome. For instance, as we depart from the spherical shape of the gas-holder the buoyancy decreases and its weight increases! And particularly, if some elongated form be constructed with conical or cigar-shaped ends, then struts must be employed to preserve its shape, and the extra weight to be thus sustained requires a balloon of such gigantic dimensions that, merely to inflate it, involves a cost quite out of proportion to any attainable result. No conditions except the exigencies of warfare would warrant the necessary expenditure. If any such conditions should ever attach to us as a nation, doubtless English talent will be equal to the emergency. Also if it be found desirable to escape from any besieged place, there will always be found sufficient of English body-linen, both male and female, for the whole population to float away, though perhaps in a makeshift manner.

The apparent anomaly before alluded to, of the lighter element and the heavy bird—the denser element and, by comparison, the light fish—is capable, however, of explanation, and its consideration will assist us in determining the conclusions at which the Aeronautical Society has arrived, viz., that flight is purely a mechanical action capable of imitation; that it is unassisted by air-cells or other contrivances for effecting levity, and that the balloon is incapable of being rendered useful to man as a means of locomotion, except in the way of waftage, and that this mode of progression in relation to the earth is capable of being materially assisted by some method of raising or lowering the balloon at pleasure, without loss of gas or ballast.

Let us suppose that the fish bears the same proportion of weight to its elemental medium as does the bird to the air. Judging from the fact that birds have been observed when

shot to sink half their bulk in water, they may be taken to be about half the weight of water, and therefore they are about 400 times heavier than the bulk of air which they displace. If, then, the fish were equal in weight to the heaviest material of which we know, viz. platinum, it would still be light in comparison to the bird in the air. For instance, a cubic foot of platinum weighs 20,000 ozs.; one of water weighs but 1000 ozs.

We have estimated the bird as being half the weight of water, equal to 500 ozs. the cubic foot, whilst one of air is only about 1.285 ozs. Therefore the instant fall of the fish to the bottom could only be prevented by such appendages as wings, and the facility to manipulate them, which, however, the density of the element in which they exist entirely precludes.

The fish, then, would fall to the bottom like a lump of platinum without the ability to rise. It is the bird without wings, for the same thing would happen to the bird, did it not possess the ability to convert the force of gravitation into horizontal force by the manipulation of its wing surface, for it thereby covers and controls the weight of air, which in a given time is included, and passed over, within the breadth of the wing-tips. If necessary, gravitation may be still further diverted by the impact of the wing upon the air, because the resistance of the air bears a certain accelerated proportion to the rapidity with which it is displaced. This fact, so important to the hopeful student of aeronautics, is simply illustrated by the alternately slow and rapid waving of any light plane surface, such as a fan.

We have seen, then, that the fact of the specific gravity of the fish, and that of the element in which it disports itself, being nearly the same, presents no encouragement to the employment of the balloon as a means of locomotion, but it does afford encouragement for the adoption of the only suggestion made in its favor by the Aeronautical Society, because the fish possesses the power, within a narrow limit, of making itself lighter or heavier, and this is just the quality which we desire for the balloon, but to which, independently of throwing out ballast, or parting with gas which can not be replenished, we have not yet attained.

In this direction, therefore, lies the one improvement of which the balloon is capable, viz., the means to secure its ascent and descent without expenditure of gas or ballast.

The power required to raise a mass which already possesses buoyancy is very slight compared with that which is requisite to propel against a resistant atmosphere. The effect also of the more simple power would be incomparably greater, because upon the supposition that a balloon required an additional power of 20 lbs. beyond the gas with which it is inflated to raise it into the air, the application of a slight mechanical arrangement would clear it from all obstructions and bring it under the influence of another power, viz., the air in motion, which would give it horizontal direction, and if that direction is not the one desired, it might raise it in search of another. The cessation of the mechanical action would also bring it down to the ground. Apply this power equal to 20 lbs. to a propeller working horizontally, and its inadequacy to effect any satisfactory result in a direct line becomes apparent. In comparison with the space to be travelled, the rate at which propulsion could be attained would be utterly insignificant.

Here let the imagination have a little play. For purposes of enjoyment it is not necessary to mount into the clouds. Our aerial yacht requires but to skim the trees and buildings. Wafted across the wide expanse, it may skim the fields and rise to the hedges. With an envelope more impervious to the escape of gas, the voyage may be prolonged. Floating day after day, at the caprice of the wind certainly, but always over fresh scenery, nothing could be more enjoyable.

During these excursions it would be possible to renew the gas by proximity to some gas works, and not seldom it might happen that, by waiting for it at anchor, a favorable wind might influence a return journey. It may here be remarked that any mechanical means such as a screw acting vertically in the car of a balloon, capable of exerting a force of thirty-five pounds, would save one thousand cubic feet of gas.

It was intended by the society which I represent to try the effect of the screw acting vertically upon a balloon, but in the mean time the War Office authorities were induced to give a trial to the inventor of a screw by which he hoped effectually to propel the balloon. He was induced to attach also an arrangement which acted vertically. The following is an extract from Captain C. Orde Browne's article, published in the *Popular Science Monthly* for October, 1874.

"The difficulty of ascertaining exactly when a captive balloon is balanced, when even a slight wind is blowing, so as to stretch the retaining rope, made the first trial a little doubtful; and after one ascent, apparently due to the working of the propeller, a doubt arose as to the exact balance of the balloon, which might have a tendency to rise, and only have been held down by the captive line, which, except at very still moments, was pulled taut by the wind acting on the balloon. It being ascertained at a still interval that the balance was good, the vertical gear was worked, and the balloon again rose. The rate of ascent was difficult to estimate; it was judged, however, not to exceed fifty feet a minute. A positive indication of the power of the propeller was thus obtained, and it should be noticed that the circumstances—if the rate of ascent only was measured—were rather disadvantageous, for the weight of the line up to the extent of forty feet was gradually added to the balloon as it rose. Had the mean rate of ascent and descent been taken, this error would be eliminated, for the descent would be favored by the weight of the rope from forty feet in length at the maximum height, down to nothing at the ground."

The balloon was now liberated, and the report goes on to say: "The horizontal gear, however, throughout the entire voyage, failed to give any satisfactory results; even allowing that the effect was perceptible, it is impossible to lay much stress upon it. Any force would give a perceptible effect if recorded with sufficient delicacy. There is no use in an insignificant effect unless it can be shown that means exist by which it could be increased sufficiently to bear a reasonable relation to the forces to which it is to be opposed."

Therefore the experiment which the society had advocated for several years, and which it had at last determined to adopt, having proved successful under disadvantageous circumstances when tried by others, the apparatus ordered was countermanded. The opinion which had been expressed also in the various reports issued by the society as to the inutility of any screw apparatus for effecting horizontal propulsion was confirmed.

It is singular that no one has taken advantage of an ascertained fact to put the balloon to more pleasurable, because more prolonged use, than has hitherto been attempted. For instance, let us consider the mode of propulsion adopted in a punt—a clumsy kind of boat, which may often be seen moored in the Thames, in mid-stream, with harmless old gentlemen seated therein, alluring gudgeon. Well, these punts are cleverly managed with a long pole. In a rapid stream, should the punter wish to go with it, he has nothing to do but to keep it off from the bank, under the full influence of the stream; and there is every probability that with a balloon so balanced a push with a long pole would send it up spinning for fifty feet or more, and one might traverse a few hundred yards before it neared the earth and required another push. The distance traversed between each push would of course depend upon the velocity of the air current. It is evident that no ballast is necessary under such conditions, therefore the absence of that would allow of reduced size of balloon. All this, however, is simply waftage.

It is believed by some that the screw may yet serve a more useful purpose than that of the translation of a merely buoyant body. By muscular effort alone all that has been done by the power of one man has been the raising of 26½ lbs. weight.

There has latterly been a more ambitious attempt, involving the expenditure of several hundred pounds of money.

It resulted from the experiments which the Aeronautical Society instituted with a view to record for the benefit of inventors the exact lifting pressure due to the wind advancing against a plane inclined towards it at different angles. These experiments, which took place at Messrs. Penn's factory, at Greenwich, were conducted by several well-known members of the council, and it was well understood at the time that if the results gave no encouragement for the attainment of success in utilizing the air as a highway, the society should be dissolved.

Accordingly, an instrument devised by Mr. Wenham was constructed by Mr. Browning for the before-mentioned society, and submitted to a powerful blast from a fan-blower ten feet long by eighteen inches square.

The direct pressure upon one foot square of steel plate, with the blast acting at right angles to the plate, was 3.24 lbs., which, according to Rouse and Smeaton's tables, evidences a wind velocity of about twenty-five miles an hour. The same plate inclined at an angle of 15° from the horizontal, received a direct pressure of only 0.33 lbs., accompanied by a lifting pressure of 1.5 lb. There were various inclinations and different areas tried, but there is no need here to go fully into the tabulated results. It will be sufficient to say that a plane of one square foot, impelled at an angle of 15° against air moving at the rate of about twenty-five miles an hour, will support a weight of one pound and a half, whilst it will only meet with a resistance to its forward motion of five ounces and a quarter, although of course there would have to be added to this the resistance due to the form in which the weight is disposed. A less angle than 15° could not be tried owing to some obstruction in the action of the instrument, but the experiment shows very great lifting force in proportion to the power which requires to be expended in the propulsion of the plane. It shows also that the ratio of the lift to the thrust greatly increases as the inclination diminishes, whilst the force to propel is equally lessened, and thus the sustained flight of birds, often with motionless wings, is in great part accounted for. There exists also another circumstance which is favorable to the extension of the sustaining surface, viz., that the lifting power relative to the square foot increases in some yet unknown ratio with the extent of surface exposed, upon the principle which has been ascertained that the more the total area of a ship's sails is cut up into portions, the less the effect.

Such fundamental experiments accord with the legitimate duty of the society to which I have the honor and pleasure to act as honorary secretary. It is left to the spontaneous efforts of individual members to work up to the data thus established.

Upon such men, whilst the world generally look with amused pity, the eyes of a cautious and watchful few are fixed, ready to take advantage of the first hopeful result. It is my earnest hope that the society will stand between such men and injustice at the time of the general scramble for pecuniary recompense.

MOY'S REMARKABLE STEAM-FLYING LOCOMOTIVE.

It will be the place here to allude to the late and very expensive attempt of Mr. Thomas Moy to construct an apparatus by means of which, in his trials in order to obtain a fulcrum upon the air, he practically tested the correctness of the facts brought out and tabulated.

Mr. Moy was an exhibitor at the Exhibition of the Society at the Crystal Palace in the year 1868. For some purpose or another, ignoring Mr. Stringfellow's light engine, which then gained the prize, he commenced to design another which he deemed more suitable for his object. This was to actuate four driving wheels, ten inches in diameter, to act in their turn upon two aero-plane wheels, six feet in diameter, by frictional gearing on the periphery. The aero-plane wheels had each twelve light wooden planes fitted to them, something like the screw-propeller, but with the important difference that the pitch was variable at every portion of the revolution. His theory was, that the action of these planes in their revolution through the air was a perfect mechanical imitation of the action of a bird's wing in the various positions that its surface assumes during the progress of flight, giving, as it does, an upward and forward thrust continually, without any downward force from the air on any of the aero-planes. The whole apparatus was placed upon wheels.

The steam-engine was contained in a case 27 inches by 27¼ inches by 7¼ inches. The diameter of its cylinder was 2¼ inches, length of stroke 3 inches. The generating tubes contained a surface of eight square feet, and in these tubes the water circulated with very great rapidity, and thereby utilized the heat in the very best manner. There was literally no framing to the engine itself, as the driving-axle ran in a tube which passed through the steam-chest. The steam was cut off at half-stroke by the slide-valve, and with a pressure of from 120 to 160 lbs. to the square inch, and 536 revolutions per minute, it might fairly be called a 3-horse power engine. The fuel used was methylated spirits under pressure, which produced blow-pipe flames.

With regard to the form of the so-called "aerial steamer" which was tried in March 1874, we may say that the engine was fixed about four feet from the ground, on a framework which also held the lamps. Other frames, extended from this on each side, take the axles of the 6-feet driving-wheels. These axles were 3 feet 3 inches in length and 1¼ inch in diameter, made of drawn brass tube, and very light and strong. An aero-plane of 50 square feet surface was fitted in front, and one of 64 square feet behind.

These were inclined at an angle of 10° from the horizontal; and Mr. Moy calculated that if the whole could be driven on the ground at thirty-five miles an hour, it would encounter a pressure from the atmosphere sufficient to support the whole weight of the machine, which amounted with its engine, fuel, &c., to 214 lbs. The driving-surface of the revolving aero-planes was equal to 60 square feet.

Before running the "aerial steamer" round the central fountain at the Crystal Palace, Mr. Moy took steps to test the correctness of the principle upon which he had been working, guided by the experiments undertaken by the Aeronautical Society. If the old theory was correct, he argued, the lifting pressure on the planes would only amount to a few ounces per square foot; if the new theory was correct the pressure would far exceed that of the old. It turned out that the old theory was wrong, and the reliability of the recent experiments was confirmed. The revolving planes having been set at an angle of 15°, the pressure was found to be exactly one pound to the square foot at a speed of twenty miles an hour; and with the angle set at 45°, the pressure was 1½ lb. to each square foot. The success of the ulterior experiment, therefore, all depended upon whether he could obtain a sufficient speed upon the ground to avail himself of the lifting-pressure due to the angle of inclination.

The fountain had a path round it. The diameter of the circle was 300 feet. A pole was erected in the centre, from the top of which two cords were attached, one to each end of the machine. Though the gravel had been rolled, the action of the machine under steam was so rough and unsteady that the experiment had to be abandoned until a suitable road could be constructed.

This was eventually effected with 8000 square feet of boarding, lent by the Crystal Palace authorities, when, after its occupation for some time by the snow, the roadway was ready for a further trial. Instead, however, of the necessary speed being attained, viz., thirty-three miles an hour, it was only possible to get about twelve, so that it was felt as a matter of regret that arrangements had not been made to run it upon a straight line of railway. The wheels, fitted for upward motion only, offered great resistance to running round a circle.

This machine, however, weighing nearly two cwt., was impelled round a circle at twelve miles an hour by the pressure of two aero-plane wheels working in the air, an achievement I believe to be quite unprecedented.

This first start from the ground has always presented great difficulties to the experimenter in aeronautics. Theory has generally favored the incline as the readiest mode of accomplishing the object, but it is certain that unless there is power sufficient to raise the weight, safety in controlling the descent under exceptional circumstances can not be secured, as the parachute form would be out of character in any machine designed for rapid transit through the air. In the difficulty in which Mr. Moy found himself, it was natural that he should turn to the vertical screw.

A ONE HORSE-POWER STEAM-ENGINE AND BOILER WEIGHING ONLY 13 POUNDS.

In the report of the Aeronautical Exhibition in 1868, drawn up by Mr. Wenham, the following paragraph appears:

"Though we are still without a precise demonstration of the power required for flight in the way that a bird flies, the force to maintain which, in some species, must be very small, yet we have some evidence of the power required to lift a weight in the air by means of vertical screws. By this method it has been demonstrated that 100 pounds may be supported by a constant force of about 90,000 foot-pounds, or three horse-power.

"Now, in the work of Mr. Stringfellow, the society has brought out the remarkable fact that a one horse-power engine can be made to weigh only 13 lbs., thus showing the possibility of obtaining flight by the repudiated system of vertical screws, even with the enormous expenditure of power that this plan is known to require."

In order to ascertain what actual lifting power could be obtained with planes moving in horizontal orbits, Mr. Moy constructed new aero-plane wheels, 12 feet in diameter, with twelve planes to each wheel, the whole presenting 160 square feet of surface, driven by a steam engine weighing 80 lbs. By placing the whole acting surface on these two wheels, an interesting experiment was carried out.

It was palpable, however, that from the conditions of the actual trial the full lifting power due to the surface, angle, and velocity could not be hoped for. These revolving planes were travelling all the time in one circle. They had not the advantage of obtaining an abutment upon a previously undisturbed body of air. The experiment was in an enclosed part of the building. Great part of its power was expended in drawing downwards a body of air. The whole weight of the machine was 186 lbs. Levers were attached to the spindle of the aero-plane wheels, which were weighted to take off all over 120 lbs. This latter weight was raised from the floor—according to the independent testimony of Captain Greenfield, of the Royal Artillery—as much as six inches under one aero-plane, and two inches under the other, this inequality being due to one wing-plane having broken.

The engine, therefore, was proved capable of raising itself, and 40 lbs. additional weight, under great disadvantages. The revolutions of these two 12-feet aero-planes were sixty-seven per minute.

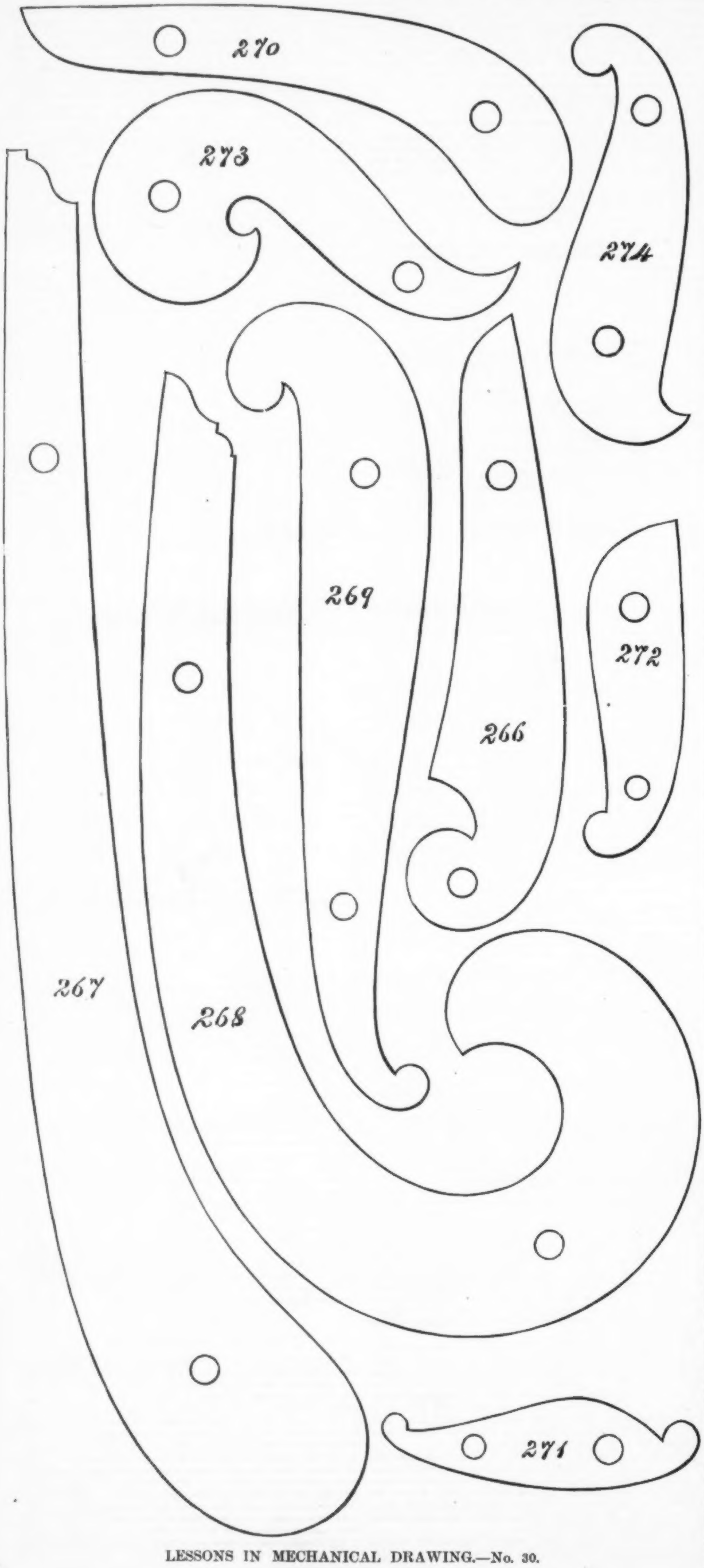
The preparations for the experiments, which have here so easily been summed up, occupied winters and summers. Repeated breakages, renewals, strengthenings, reconstruction, readjustment, both in engine and apparatus, testify to the patient perseverance of the inventor, and those associated with him. And though lastly mentioned, yet by no means the least, was the constant leakage of the not too auriferous money-bag.

This, however, is the common lot. The situation can only be estimated by the spectator—such as I am—of many abortive attempts.

My space is consumed before my pen has run dry, else I might adduce some more reasons why such earnest workers in the solution of the profoundest problem which ever absorbed the brain-power of aspiring man should be encouraged by the wealthy to go on and progress in aeronautics.—*Popular Science Review.*

AFRICAN ARROW-POISON.

MM. GALLOIS and HARDY have succeeded in isolating a poisonous principle, which they call *erythrophlæine*, from the bark and leaves of *Erythrophlæum guineense* (Nat. Ord. Leguminosæ) and an allied species from the Seychelles, *E. Couminga*. It exerts a specific influence on the tissue of the muscles, above all on that of the heart. When introduced into the circulation of a warm-blooded animal it causes muscular twitchings, followed by great dyspnœa and cardiac paralysis. In cold-blooded vertebrates, the muscular system is gradually paralyzed and relaxed, the nerve-centres and fibres retaining their functional vitality long after the heart has ceased to beat and the voluntary muscles have lost their contractility. The heart fails before the other muscles, simply because it receives a greater supply of the poisoned blood in the same time. Atropia is unable to rouse the heart when paralyzed by erythrophlæina; curare seems to delay the manifestation of the symptoms.



LESSONS IN MECHANICAL DRAWING.—No. 30.

LESSONS IN MECHANICAL DRAWING.

By Prof. C. W. MacCord.

No. XXX.

The drawing of intersecting surfaces, of which we have given some illustrations, involves the construction of curves by means of points. In some cases we have seen that the curves derived in this way are definite mathematical ones of known properties, and capable of determination in ways entirely different, and in no wise dependent on the intersection of surfaces. Of course, all these lines are susceptible of mathematical investigation, and probably different ways might be deduced for drawing all of them. But the benefit to be derived from such investigation is probably, in fact we may safely say positively, not great enough to pay for the time and trouble. Much labor and ingenuity have been expended upon the devising and construction of instruments for drawing some of these by continuous motion—particularly in the case of the ellipse—but as yet with very inadequate results.

Elliptographs there are, to be sure, and some of them very neat and ingenious, and capable of drawing that curve in all proportions with great accuracy. But the difficulty is that it requires considerable time and great care to adjust them for any given case. It usually happens that a given ellipse is to be drawn in a given position; and an expert draughtsman can construct it by points and draw it with "sweeps" in less time, if any thing, than he can adjust and locate the elliptograph, and draw it with that. And this is only one, while we are continually meeting in practical operations with a great variety of other curves not circular, nor yet of any other known or named form; the preceding examples are but a few. It will therefore be apparent that skill in the use of these curved rulers is an important qualification of the draughtsman. This will be still more strikingly seen by considering a single instance of the application of such curves—viz., in the laying out of the teeth of wheels. We

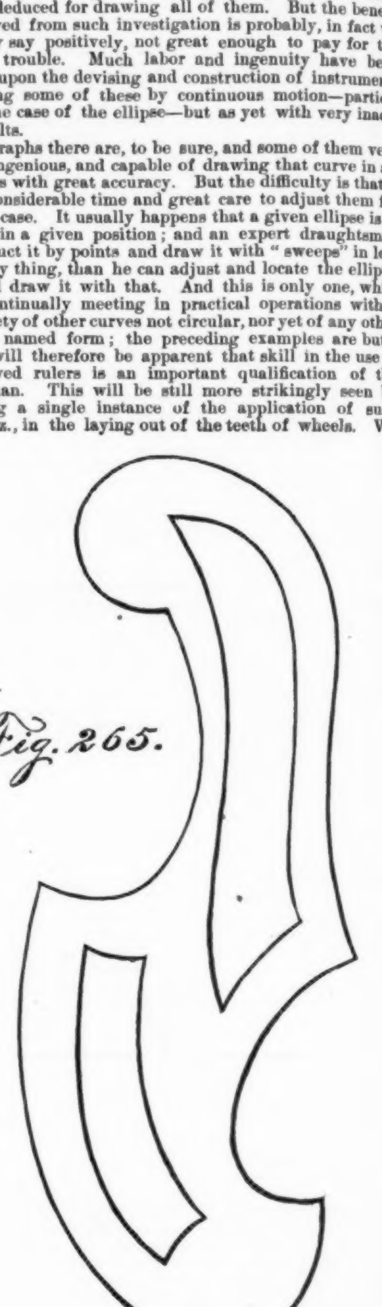


Fig. 265.

presume that many of our readers will wish to know how this is done, and in due time some of the more common forms of these teeth will be given, with the modes of constructing them; and when that time comes, such readers will be prepared to put those processes into execution in a much more satisfactory manner, if they have in the mean while made themselves expert in the mechanical process of drawing either those or other curves in the manner which they will then be compelled to adopt. For work of that kind is not to be considered satisfactory merely because it is conducted on correct principles: if the lines laid down by the designer are followed, the result will be any thing but good if the lines themselves are faulty, no matter how thoroughly the operator understands the principles. It is not what he knows he ought to do, but what he knows how to do and does do, that determines success or failure: the reasoning must be correct, but the execution also must be faultless.

We therefore continue exercises of this kind, the first new one of which is the common cycloid, shown in Fig. 262.

This is the curve described by a point in the rim of a car wheel, as the latter rolls along a level rail. In the figure, the wheel may be represented by the circle whose centre is C, and the rail by the right line L L, to which the circle is tangent at A. Suppose the circle to roll along the line to the right, like a hoop, as indicated by the arrows; the centre will travel in the right line C F, parallel to L L, but a point in the circumference of the circle will move in a path which partakes of the circular motion of the wheel as it turns on its axle, and also of the rectilinear advance, which latter is clearly the same for every point in the wheel.

Now, as the circle rolls on the line without slipping, it measures its circumference off on the tangent; each point of the curve in its order comes into contact with a point on the line, so that the part of the line rolled over is exactly equal in length to the part of the circle which rolls over it. If we suppose a pencil to be fixed in the circumference at P, the extremity of the diameter A C P, it will then be clear that when

the circle has rolled far enough to measure off the semi-circumference, P will have come down to the line L L at I, the distance A I being equal to that semi-circumference; and the whole circle will have travelled the same distance to the right, the centre being then at F, perpendicularly over I. It will also be seen that if we divide the semi-circumference into equal parts at the points 1, 2, 3, etc., and the line A I into the same number, as shown, the points of division on the circle will successively come into contact with the corresponding points on the tangent. Thus the point 2 on the circle will coincide with the point 2 on the line, and at that time the centre, being always vertically over the point of contact, will be at D; the *radius of contact*, D 2, will be the one which in the original position of the circle is marked C 2. The radius C P in that original position is called the *generating radius;* it makes with C 2 an angle P C 2, which evidently is not changed by the action of rolling; consequently, if in the second position of the circle we make the angle 2 D G equal to 2 C P, D G will be the position of the generating radius, and G must be a point on the cycloid traced by P.

The same result may be reached in another way, thus: We may suppose the rotation and the forward motion of the circle to take place separately; for example, the circle may be first turned through the angle A C 2, and then pushed forward along the tangent, without rotating, through a distance equal to the arc A 2. The turning would bring the triangle 2 C P into the position A C 4, as shown in dotted lines, and the sliding forward will again bring it to the position 2 D G, the point 4, as indicated by the dotted line, 4 G, moving, like the centre and the point A, horizontally. In like manner, if the circle be turned through the angle 4 C A, the triangle 4 C P will assume the position A C 2; then if it be pushed forward through the distance A 4 on the tangent, equal to the arc A 2 4, this triangle will be found as 4 E H, the generating radius C P taking the position E H, and the radius of contact E 4 corresponding to C 4 in the original position. We have shown the circle in four positions, the generating radius being indicated as a skeleton crank, which, with the above explanation, will, we think, enable the reader to form a clear idea of the manner in which the motion of the tracing point is controlled, and of the methods of finding points in the cycloid; by drawing the circle in intermediate positions, as many more points may be determined as the judgment of the operator may dictate.

We have explained this method of drawing the cycloid—that is, by finding points in it—first, because it is sometimes necessary to do so, for one thing; but a more important reason is, that this operation, of rolling a circle or other curve along a line, is one which will subsequently be found of great use, and we wish the reader if possible to understand thoroughly and precisely what it is and what it means. Assuming that he now does, we proceed to remark that curves of this nature—that is, those which are traced by a marking point controlled by a line rolling upon another—may be more accurately as well as more expeditiously drawn by another method, which is also illustrated in the same diagram.

We mean the method by tangent arcs. It has been previously stated, that the eye is capable of judging accurately of the fact of tangency; so that, for example, a right line can be drawn tangent to two given arcs, with as great precision as it can be through two given points. And if a number of arcs be given, a curve can be drawn tangent to them all, as accurately as if the points of tangency were known; and, in fact, such an *envelope*, as it is called, can be drawn more accurately than the same curve could be if the points alone were given. This arises from the circumstance that the direction of any curve at a given point is the same as that of its tangent: such arcs, then, give an idea of the *direction* as well as of the location of the required curve; which the points of themselves do not. This operation of drawing a curve or other line is purely mechanical: in the case of two arcs only, we draw a right line tangent to them by merely applying the straight edge, or ruler, in such a way as to draw the line by it. And this way is illustrated in Fig. 263, in which it is seen that the ruler is not placed so as itself to touch the arcs, but so as to leave a little *daylight* between its edge and the two curves; the eye must judge, and it can judge with unerring accuracy if carefully trained to it, of the equality of the distances between the edge of the ruler and the two arcs respectively. In short, the operation is exactly analogous to the drawing of a line through two given points as in Fig. 7.

Substantially the same precaution is to be observed in drawing an envelope to any number of arcs, as illustrated in Fig. 264.

In this case we make use of a curved ruler, technically called a "sweep" or a "mould." This is placed so that the *edges* of the given arcs, so to speak, may just be seen equally projecting beyond the edge of the sweep, and the envelope is then drawn tangent to as many of them as may be, after which its position is changed, or a new one is selected, and so placed that a little of the envelope already drawn might if necessary be again drawn by it, and that the continuation thereof shall be tangent to the succeeding arcs, and so on. We have already mentioned this as necessary in order to secure a perfectly fluent and continuous line, without evidences of the use of different sweeps; but the matter is important enough to warrant reiteration.

Now, to return to our friend the cycloid. In the original position of the generating circle, the centre being at C, the point of contact A is obviously the fulcrum, or stationary point, about which the whole circle is at that instant turning. To be sure, the circle is turning on its axis; but at the same time it is moving forward in a right line, and the rotatory motion of A to the left is just neutralized by the bodily motion of the whole wheel to the right. If we imagine the diameter A P to be a lever, pivoted on a pin at A, it will be clear that it will for the instant move precisely as it now moves when the circle begins to roll. The motion of P, then, at starting, is in the direction of a tangent at that point to a circle described about A as a centre, with AP as radius; and the motion of any other point in or connected with the wheel will at the instant of starting be in the act of describing a circle about the same point A.

Extending this reasoning a little, we may in general say that at any instant the point of contact is the fulcrum or centre about which the entire wheel is turning. Thus when the centre reaches D, the point 2 on L L is this centre; the point 2 on the circle at that instant coincides with it, and the distance 2 P has not been changed, and consequently it is the radius of the circle which P is then in the act of describing about 2 as a centre. We have already, in explaining the modes of finding points on the cycloid, shown that the triangles 2 C P, 2 D G, are, in fact, identical, the latter being only a new position of the former, and in this new position of the circle it will now be easily seen that the motion of G is the same as though 2 G were a lever pivoted at the extremity 2.

If, then, we describe about 2 on L L, with radius 2 P, the arc *a* G *b*, the cycloid will be tangent to this arc. In like manner, if we take any point on the tangent as a centre, and as radius the distance from the tracing point to the corresponding point on the circumference, the cycloid will be tangent to the arc thus determined.

As, for example, the point 4 on the circle will come into contact with 4 on L L; about the latter point with radius equal to the chord 4 P, describe the arc *c* H *d*, to which the cycloid will also be tangent.

The construction of the curve by this method, it will be seen, involves very few lines, although a great many are seen in our diagram. These, however, are for illustrative purposes, and not at all necessary in practice. The most expeditious mode of proceeding is, having drawn the vertical and horizontal centre lines, to describe the circle first, and at once to set off the points 1 and 5 with the same radius, from 3 as centre, and from A and P to set off the points 2, 4, with the same radius, thus dividing the semi-circumference into six equal parts. Next draw L L, and on it rectify the arc A 2 as shown, and set off its length three times on the right and left of A P; bisect A 2 at 1, and set off the intermediate divisions 1, 3, 5, on the tangent; then about the points of division 1, 2, 3, etc., on L L, in order, as centres, describe arcs with radii 1 P, 2 P, 3 P, etc., introducing, if desirable, intermediate ones by subdividing the spaces on both the circle and its tangent; thus the curve may be mapped out with any required degree of precision, and drawn with great facility. But, as previously pointed out, this method determines the curve only, but does not locate any point in it.

We can, however, very readily ascertain the position of the marking point corresponding to any point of contact; for instance, supposing the cycloid to have been drawn in this manner, it might be required to find where P will be when the circle touches L L at the point 2.

Erect at 2 the perpendicular 2 D, which gives the position of the centre, and describing an arc of the rolling circle to cut the cycloid in G, we thus fix the location of that point.

If this intersection be too acute, as it may be when the required point is not far from P, we may determine it with greater precision thus: extend 2 D to cut the circle in N, and make the arc N G equal to the distance A 2. In this illustration we have for convenience selected a point of contact 2 which was used in the laying out of the curve, so that the arc N G is known: had it been, however, between the points of division, the process would have been the same, except that it would have been necessary first to find an arc of the generating circle equal to the distance of that assumed point of contact from A.

Now, in regard to this curve, it is to be observed that its highest point or vertex is P, where it has a horizontal tangent; also its curvature is least at that point, and increases as the centre of the rolling circle approaches F; and F I is tangent to the cycloid at the terminal point I, where it meets the *base line* L L.

It is so apparent that if the generating circle roll to the left from its central position C, the point P will trace a path precisely similar to the right-hand part P G H I, that no allusion to it has been made, nor was it necessary to introduce any construction lines in that part of the diagram.

The circle having reached F, it is self-evident that if we roll it back again the point P will simply retrace its cycloidal path; and if it go on rolling to the right, P will trace another branch, exactly similar to the one already drawn, and so on in succession. A portion of the new branch, I M, is shown; in regard to which it is to be remarked that since it is to be symmetrical with I K it is not necessary to construct it in the manner employed for drawing the first branch; but it may be copied by setting off F M = F K on the centre line, and drawing a series of horizontal ordinates, to be made equal on the opposite sides of the vertical line F I.

Especial attention is called to the fact that the reverse branches, I K and I M, have a common vertical tangent at I, which latter point is common to the two branches; so that the latter do not intersect, nor should they appear to do so.

Such a junction of two branches of a curve is called a *cusp*, and is quite different from an intersection, inasmuch as in that each branch has a separate tangent, and these tangents intersect each other also; though of course a very acute intersection will closely resemble an actual cusp.

We shall subsequently have occasion to make use of other curves, analogous to the cycloid, in which these cusps appear, and it is of considerable importance that they shall be accurately drawn; which is the reason for strongly advising the student to make himself thoroughly familiar with every detail of the methods by which the cycloid is constructed, and to practice himself in drawing it until he can do it at least as well as it is done in the diagram. And in one respect he should do it better—or, at least, differently—that is to say, he should draw it with as fine a line as possible. In an illustrative diagram, as has been remarked, it is not only permissible but advisable to give prominence to the result, which in this case is the curve, by making it in heavy lines; but for practical constructive purposes, especially of the kind for which these curves will be employed, every line should be drawn as finely and sharply as it can be.

Now, there are means by which the cycloid, as well as the ellipse, may be drawn by continuous motion; but the objections urged against the elliptograph apply with equal force to mechanical contrivances for describing other curves. And having said so much in regard to the construction of such lines by points and tangent arcs and in regard to the use of sweeps or curved rulers, it is but fair to add some hints as to the selection of instruments of this description. For it is also fair to assume that among our readers there may be some who are both able and desirous to provide themselves with something of the kind; and in the shops of the dealers there are to be found such a prodigious number of such things, of all conceivable shapes and sizes, that the novice might well despair of making the best selection. He will find whole nests of ellipses of various proportions, parabolas on all scales, hyperbolas of assorted sizes, and scrolls curiously misnamed universal curves, in countless numbers.

In Fig. 265 we give a specimen of one of the latter for the express purpose of cautioning all who wish to be satisfied with their purchases, against being induced by any persuasion whatever to have any thing to do with curves of the numerous family to which this belongs.

We do not mean to say that all of them are equally bad, but we do say that, as a rule, they are all bad in a greater or less degree—bad, that is, for the purposes of the mechanical draughtsman; though possibly there might be found uses to which they are well adapted.

The difficulty appears to be that in the effort to combine in one implement a great number of perceptibly different curves, no single one is continued for a sufficient distance to make it practically of efficient service, and curves which have no natural relation to each other are joined together. Better far than these are the ellipses, parabolas, and hyperbolas above mentioned; indeed, it may be said that definite mathematical curves will be found most useful in drawing, and that a better sweep will result from extending a single curve than from making up its form of two or more parts of different ones, however perfect the tangency.

For the guidance of those who may need it, we give in Figs. 266 to 274 the exact forms and dimensions of a number of

Fig. 264.

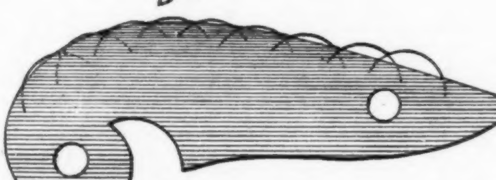
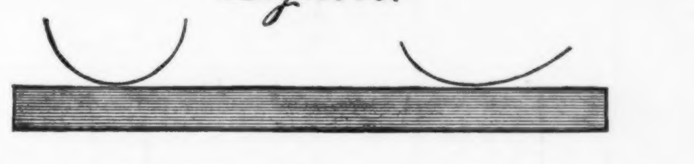


Fig. 263.



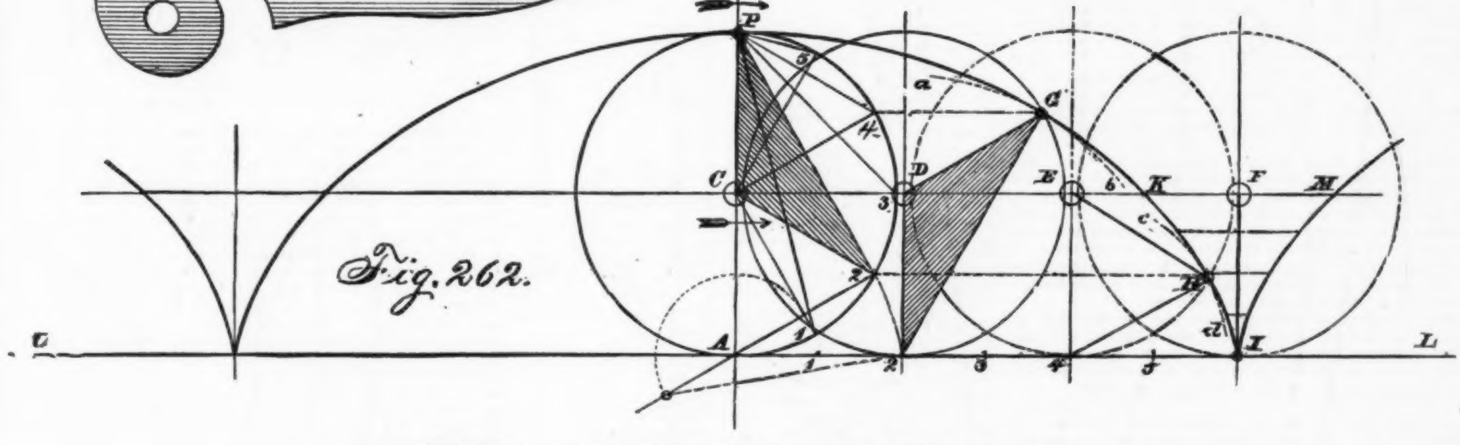


Fig. 262.

LESSONS IN MECHANICAL DRAWING.—No. 30.

sweeps, which long experience has proved to be of very useful figures. In making plans of vessels on various scales, it is necessary to have a large number of these sweeps of different sizes as well as forms, in order to suit the almost endless variety of curves which the "lines" of ships present, and those made by a single Danish manufacturer attained a world-wide and just celebrity. Since his death, the curves of his designs have been reproduced in this country; the ones here given are exact copies of those of them which are of the greatest and most varied utility in mechanical drawing, and with these and the one shown in Fig. 264, the most of the curves likely to be met with in ordinary operations can be drawn; though, of course, in operations on a very large scale, other and larger sweeps may be found convenient, or even necessary. With the exception of 264, the numbering is in the order of the general utility of the curves; and we recommend our readers not to be contented with those which merely have a general or even a close resemblance to these, but to insist on being furnished with these precise articles —if they are not to be had in one place, try another. One more word in regard to using them; which is, that the *convex* side should be used as the ruler, and not the concave or hollow one; this applies, of course, more particularly to those which, like 267 and 268, are wholly convex on one side and concave on the other; the former only is worked carefully to the true mathematical line, the inside being cut out with no special care, merely to save material; the sinuous curves, or those of contrary flexure, like 269, are as correctly made on one side as on the other.

FRENCH ACADEMY OF SCIENCES.

OCTOBER.

On the Industrial Fabrication of Nitro-Glycerine. By M. Gelis.—Nitro-glycerine is usually produced by mixing glycerine simultaneously with sulphuric and nitric acid. The heat disengaged is considerable, and there is always danger that the detonation of the product may thus be caused. The author avoids this difficulty by mixing the glycerine first with the sulphuric acid, which produces an inexplosible compound which the heat does not affect. Then after cooling he adds the nitric acid, when the amount of heat evolved is so small that no peril is incurred.

On the Electric Eel. By Professor Rouget.—This author points out that the electric apparatus of the *gymnotus* is nothing but a cluster of anastomosic nerves, supported by conjunctive tissue. No special cellule is encountered, and the electric current generated is attributed solely to nervous action.

On the Agricultural Effect of Atmospheric Electricity. By M. Berthelot.—Continuing his important researches on the above subject, M. Berthelot submits cellulosic substances to natural electric influences, the intensity of which is measured at each instant. In an apparatus exhibited, paper was submitted to air or in nitrogen, at a tension corresponding to the average of 3½ Daniell couples. The nitrogen was fixed in the paper, which, submitted to sodated lime, disengaged ammonia-like organic substances. The conclusion is that the tissue of vegetables under the influence of the atmospheric electricity, constantly fixes nitrogen borrowed from the air, and thus develops the nitrogenous compounds characteristic of life.

On Photomicrographic Researches upon the Effect of the Reduction of Silver Salts in Photographic Proofs. By M. J. Girard. —On examination under strong magnifying power, a negative cliché developed indistinctly by sulphate of iron or pyrogallic acid shows in the clear portions crystals uniformly scattered and about $\frac{1}{30}$ of an inch in diameter. These are iodide of silver crystals, and as they expand over the sensitive surface they constitute a layer impermeable to light, and hence are the causes of frequent photographic failures.

On the Chemical Reactions of Gallium. By M. Lecoq de Boisbaudeau.—A solution of a pure salt of gallium is precipitated by sulphydrate of ammonia. An excess of reagent does not remove the gallium so long as the sulphate of zinc is in sufficiently small quantity to be itself dissolved.

On Electric Discharges. By M. A. Boillot.—Two tubes filled with powdered graphite are placed parallel to each other, and are separated for a variable distance which depends on the intensity of the electricity and the nature of the currents desired. Each tube carries at one of its extremities a platinum wire communicating with the interior carbon. The wires are opposite to each other, and are connected with the electric sources. Discharges are produced along the entire length of the tubes. The author states that by this apparatus ozone may be produced in large quantities relatively to the air or oxygen employed, if the source of electricity be sufficiently powerful.

On the Industrial Applications of Phosphide of Copper and Phosphor Bronze. By MM. De Ruolz-Montchal and De Fontenay.—The authors present two bells of similar dimensions, one of phosphide of copper in the proportion $\frac{8}{100}$, the other of bronze in the usual proportion of 78 copper to 22 tin. The sound of the first possesses qualities of acuteness, timbre, and intensity much superior to the second. Moreover, the phosphide of copper is homogeneous everywhere, while the same is not the case with bell metal. The authors introduce phosphorus into bronze in the proportion of $\frac{8}{100}$. This alloy, harder than ordinary bronze, wears longer, and may be remelted indefinitely.

On the Limits of Fire-damp Explosions and on a new Property of Palladium. By M. Coquillon.—Fire-damp explosions may occur between much greater limits than is generally supposed. Thus, for one part of fire-damp, the proportion of air may vary from 6 to 16, although at either limit the danger is not imminent. Palladium may be carried while at a red heat, even in the midst of the most detonating mixtures known.

On the Distribution of Magnetism. By MM. Trèves and Durassier.—The authors state that the distribution of magnetism in a magnet is strongly influenced by the quantity of carbon contained in the steel. On comparing magnets containing 1, ½, and ¼ per cent of carbon, it is noted that the less there is of the latter, the more uniform is the distribution of magnetism. Carburization serves to concentrate the magnetism at the poles.

On a new Construction of the Electric Lamp. By M. Jablochkoff.—This invention obviates the use of the clock-work mechanism employed for keeping the carbon points at proper distance apart as they are consumed. The author places two pencils of carbon parallel to one another, and separated by a distance suitable for the production of the electric arc between their extremities, and envelops them in a solid cylinder of clay, refractory stone, or other highly refractory material. In this way a kind of candle is formed of which the pencils constitute a double wick. For use, the candle is inverted so that the protruding ends of the carbons are downward. With the now upper ends battery connection is established. The electric arc is thus produced between the lower extremities, and as the latter burn away the intense heat volatilizes the refractory material above them, so that new portions of the pencils are constantly exposed, and these, of course, remain at an invariable distance from one another. The volatilized material enters the electric flame and is said to increase its power. Several of these candles M. Jabloskoff arranges in circuit, so that by a single current he is enabled to produce a large number of lights.

OIL-PIPE LINES.

IN 1865 Mr. Samuel Vansyckle conceived the idea of extending the tubing of the well to the station desired, and laid the first line of two-inch tubing, six miles in length, from Shamburg to Miller's Farm, having two intermediate pumping stations, which were afterwards abandoned as unnecessary.

Later experiments demonstrated the superiority of the ordinary tubing, which was almost universally employed in the construction of pipe lines until 1873, when the United Pipe Company introduced three-inch casing on a line extending from Modoc to Raymilton, an example followed more recently by the Conduit and other new organizations of this description.

The success of the line mentioned led to the laying of others, until the whole oil region is interlaced in all directions with them, as will be more apparent by consulting the table published in this number.

But little need be said as to the construction of these lines. The pipe used is what is known as lap-welded or butt-welded tubes, averaging from two to six inches in diameter, with wrought-iron screw couplings. This pipe is laid on the surface of the ground, along roads or across the country indiscriminately, following the contour of the country up hills and down valleys. To allow for expansion and contraction the pipe is laid, not in a straight line between any two points, but in curves, the curves not being so great but that the force of contraction will draw the pipe without breaking it.

There are but few gravity pipes, the oil being generally forced through the lines by pumping, the number, location, and size of the pumps being determined by the levels or grades of the pipe. The average capacity of the lines is 1500 barrels per day, some going as high as 3000.

The following is the total mileage of iron pipe used for conveying oil in the oil regions of Pennsylvania:

LINES.	SIZE OF PIPE.		TOTAL MILES.
	2-in.	3-in.	
	MILES.	MILES.	
Atlantic Pipe Co.	80	10	90
American Transfer Co.	50	22	72
Aut. and Oil City Pipe Cos.	..	..	136
Brady's Bend Iron Co.	1½	.	1½
Church Run Pipe Co.	6	..	6
Charley Run Pipe Co.	1½	..	1½
Cherry Tree Run Pipe Co.	25	..	25
*Columbia Conduit Co.	71	51	128
Conewango Pipe Co.	5	..	5
Franklin Pipe Co.	9	1	10
Grant Pipe Co.	120	..	120
Hunter & Cummings Pipe Co.	5	½	5½
Karns Pipe Co.	82	..	82
Keystone Pipe Co.	30	..	30
Milton and Sandy Pipe Co.	52	1	53
McKean County Pipe Co.	16¾	..	16¾
New York Pipe Co.	40	..	40
New York and Alleghany Oil Co.	5	.	5
Octave Pipe Co.	20	..	20
Olean Pipe Co.	33	..	33
Pennsylvania Transportation Co.	380	..	380
Prentice F. & Co.	¾	..	¾
Pacific Pipe Co.	2	..	2
Private Pipe (Foxburg)	2	..	2
Richard Jennings Pipe Co.	3	..	3
Relief Pipe Co.	100	..	100
†Rochester and Oleopolis Co.	30	3	40
Sage Run Pipe Co.	5	..	5
Shaffer Run Pipe Co.	1½	..	1½
Smith's F'y & I. Run Co.	5	..	5
Titusville Pipe Co.	40	..	40
Tidioute Oil Pipe Co.	11	2	13
Taft & Payne Pipe Co.	10	..	10
Union Pipe Co.	300	..	300
‡United Pipe Co.	276	24	300
Total Mileage			2,081¾

* 6 miles of 4-inch included in total.
† 7 miles of 6-inch included in total.
‡ Operating Milton, Sandy and Franklin Lines.

Atlantic Pipe Co. collects oil in Clarion County, and delivers it to the Valley R.R. at Foxburg through 3-inch pipe, and through 2-inch pipe at Sligo, to the Sligo Branch of the Low Grade R.R.

American Transfer Co. collects oil in Clarion County, and delivers it through 2 and 3 inch pipes, at Emlenton, to the A. V. R.R., and at Oil City.

Antwerp Pipe Co. collects oil in Clarion County, and delivers it through 2 and 3 inch pipes, at Fullerton, to the A. V. R.R., and at Oil City.

Columbia Conduit Co. collects oil in Butler County, and delivers it through 2, 3, and 4 inch pipes, at Montrose, to Pittsburg refineries; also ships in barges down the Ohio River.

Grant Pipe Co. collects oil in Armstrong and Butler counties, and delivers it through 2-inch pipes, at Parker's, to the A. V. R.R., and barges on the Alleghany River.

Karns Pipe Co. collects oil in Butler County, and delivers it to the A. V. R.R., and barges on river at Parker's; also at Hilliard's Station, to the S. & A. R.R.

Relief Pipe Co. collects oil in Butler County, and delivers it at Sarah Furnace to the A. V. R.R.

United Pipe Co. collects oil from all parts of Butler County oil field, and delivers it through a 3-inch pipe, to the Franklin Branch of the L. S. & M.S. R.R., at Raymilton; through 2-inch pipes to the Shenango & Alleghany R.R., a branch of the A. & G. W. R.R. at Harrisville and New Hope; to the A. V. R.R. at Brady's Bend, and Monterey, in Clarion County; collects from Clarion County oil field, and delivers it at Oil City; collects the heavy oil around Franklin and delivers it to railroads and refiners at that place; also collects the oil from Bullion Run and delivers it at Raymilton.

Union Pipe Co. collects oil from Clarion and Armstrong counties, and delivers it at Foxburg and at the mouth of the Clarion, to the A. V. R.R. and river barges; also collects from all parts of the Butler oil field, and Bear Creek, in Armstrong, and delivers at Parker's and vicinity, to the A. V. R.R. and river barges.

Pennsylvania Transportation Co. collects oil in Warren, Forrest and Venango counties, and delivers it to the P. T. & B. R.R. at Tidioute, Trunkeyville, Shaffer, Miller, and Titusville; also collects oil in Butler County oil fields, and delivers it to the A. V. R.R. and river barges, at Brady's Bend, in Clarion County.

Hunter & Cummings' line collects oil on the cross belt in Butler and Armstrong counties, and distributes it through 2-inch pipes at Brady's Bend to the A. V. R.R.

The balance of the pipe lines collect and deliver the same in the various parts of the upper oil fields. Some of the principal ones are as follows:

Taft & Payne Pipe Line collects heavy oil in and around Franklin, and delivers to the railroads and refineries at that point.

Cherry Tree Run Line collects on Cherry Tree Run, in Venango County, and delivers to P. T. & B. R.R. at Rynd Farm.

Titusville Pipe Co. collects at Pleasantville, Colorado, Pithole, and other points, and delivers it to railroads and refineries of Titusville.

New York Pipe Co. collects at Hickory, Fagindas, and vicinity, and delivers at Titusville, also at Garland to the P. & E. R.R.

Octave Pipe Co. collects from the Octave district near Titusville, and delivers to railroads and refineries at Titusville.

Warren Pipe Co. collects at Warren, and delivers to the P. & E. R.R. at that point.

Conewango Pipe Co. collects at Warren, and delivers to the D. A. V. & P. R.R. at Warren.

McKean County Pipe Co. collects oil in the Bradford district, and delivers it to the B. B. & P. R.R. at Bradford.

Olean Pipe Co. collects oil in the Bradford district, and delivers it to the B. N. Y. & Phila. R.R., at Olean, N.Y.—*Stowell's Petroleum Reporter.*

NEW USE FOR REFINED OIL.

A NEW use to which petroleum oil can be put is found in the preparation of the beds for the growing of tobacco. Hitherto it has been the practice to burn off the remnants of the old crop before setting in the new, by means of cordwood, as much as thirty cords of wood being necessary to a bed of 1000 yards square. It has now been found that the work can be more quickly and better done by means of refined oil, one gallon being sufficient to treat 100 square yards with. The way to use the oil is described thus: The bed is first to be cleared off, as if for burning by wood in the old way. After this is done the oil must be applied evenly and uniformly from a watering pot. As soon as the oil is thus applied, the match is to be touched and the job is done. The latter part of the work must be done quickly, in order to avoid danger to the person. If it be desirable to burn deeper, before applying the oil hoe up the bed, and then proceed as above directed. The oil will penetrate the soil as far as it is worked by the hoe, and will burn as deep as the oil penetrates. It is thought that the oil can be used with equal value in the preparation of ground for early vegetables by warming it, and giving the stimulus supposed to be given by guanos, besides being destructive to worms and insects.—*Titusville Herald.*

IMPROVED LUBRICANT.

IN making his lubricant, which he describes as particularly applicable to colliery wagons, Mr. George Newton, of Bow, takes lime, which is first slacked, and then to this is added oil, preferably tar oil, and both are thoroughly mixed together, and then the water and impurities are drawn off in form of liquid. To this compound he then adds a suitable proportion of resin oil, which is thoroughly mixed therein. The above when thoroughly mixed forms a lubricant which is useful for slow-moving machinery, such as colliery wagons, but where friction is great, as in fast-moving machinery or carriages or wagons, then to the above he adds any suitable soda, for instance, caustic soda in solution; and he sometimes in the case of this latter form of lubricant dispenses with the lime, or he sometimes makes the lubricant of lime, resin oil, and pitch, which latter has been previously dissolved with tar oil; or he can use the whole of the above-named ingredients combined in suitable proportions in making another form of lubricant. For some purposes in making the lubricant, the lime, oils, and pitch are boiled.

BOYD HILL GAS WELL.

THIS well is located in the heart of the City of Pittsburg, on Boyd Hill, at the head of Third avenue, near Anderson & Wood's steel works and H. Lloyd, Son & Co.'s rolling mills, on a degree representing the strike of the oil-bearing rock from Petrolia, through St. Joe to Great Belt City, in Butler County. The owners of the well expect to find gas (and possibly oil) at a depth of not over 2200 feet, provided the strike of the rock continues from Great Belt City to this place on the same degree. A vein of salt water was struck at 1615 feet, which is thrown up by the action of gas, and continues to produce 3000 bbls. per day with a specific gravity of 10 per cent, eight bbls. of which will make one of salt.

In order to utilize the salt water, the fresh water has been shut off by a casing 8 inches in diameter, and 412 feet long.

The salt water has also been cased off with a 5⅝-inch casing, to the depth of 1775 feet, and is now flowing constantly outside of the casing as above stated, while the contractor is drilling a dry hole inside the casing for gas, oil, or whatever may be found. This well has a longer string of casing in it, by some 400 feet, than any other well put down in Western Pennsylvania, or in any well of which we have knowledge.

The hydrostatic pressure of this column of salt water 1775 feet high, is calculated at 770 lbs. to the square inch, less the attraction on the walls of the well; consequently the first attempt to case the volume of salt water proved a failure, as the casing was of the ordinary kind used in the oil region for such purposes, and collapsed at about 1600 feet from the surface.

The second attempt to case it was made a success, by using a casing of double the thickness 600 feet from the bottom upward, and the remainder of the ordinary thickness. The well is now down 1860 feet, and it is expected that the third or oil-bearing sand of Butler County will be found at 2200 feet.—*Stowell's Petroleum Reporter.*

PEANUTS *vs.* OLIVES.

MARSEILLES annually derives large quantities of peanuts from Pondicherry, which shipments have recently been largely augmenting. In 1874 thirty thousand bags were imported, and in 1875 one hundred and eighty thousand bags. As peanuts are almost unknown as an edible in France, we infer that pressure is brought to bear upon them for the extraction of their oil, which turns up afterwards in our salads and Castile soaps.

THE TREATMENT OF BURNS.

SURGEON W. R. E. SMART details, in the *British Medical Journal*, the treatment of the injured at the explosion of the "Thunderer."

The local treatment was by oil and lime-water on cotton wadding, on every part, to the fourth and fifth days, and to a later period, in the majority of cases, on the limbs. Where suppuration commenced on the face, head, and neck, and the upper part of the chest, this being found inconvenient and dirty, causing distress to the patients, the moist dressing was changed for dry, cotton wadding was abandoned, the parts were washed with carbolic oil, and then dusted, from a common flour-dredger, with a powder consisting of one part of oxide of zinc, one of carbonate of magnesia, and two of powdered starch, sifted on wherever moisture appeared, care being taken to keep the facial orifices free. By this means a firm incrustation was formed as a mask to the features, which remained intact, excluding the atmosphere. Under its protection, the process of scabbing, by which nature heals most of the wounds and sores of the lower animals, and of man himself in an uncivilized state, went on most favorably, so that, on the detachment of the crusts, the parts were found to have healed, which they did in the neck, face, and head very rapidly, except as regards the ears; the pinna, probably from the restlessness of the patients, gave trouble in many cases, and in some was the seat of abscess.

The results are that only in one case is there any permanent indicated cicatrix on the face, producing deformity, and that in the parts where the mode of treatment could not be well applied. The advantages of this plan of treatment were first seen by me among the blacks in the Island of Mauritius, who, being employed in sugar boiling, often meet with very severe scalds by superheated syrupy fluid. The material I saw used by them was nothing but pulverized calcined sea-shells, dusted on wherever moisture oozed out through cracks in the crust, which remained on until scabbing had taken place, not only excluding the atmosphere, but preventing the deposit of larvæ by flies, often a severe embarrassment in treating wounds in tropical climates.

I think so favorably of this treatment in the prevention of unsightly scars as to lead me to suggest its applicability in confluent small-pox, at least to the parts usually exposed. It was also used to a minor degree in some of the sores on the limbs, more especially of the hands and forearms, in some of which the scalds were so severe that the cuticle, and in one the nails with it, came off in the form of gloves; and it is satisfactory to know that, although attenuated fingers and very thin cuticle will affect the sufferers for a time, yet there are no cases of contracted tendons to be recorded.

I mention this as an efficacious mode of excluding atmospheric air, and not as any new principle of treatment. In fact, it is but one of the numerous means to the same end which have been kindly suggested from many sources, among which I may enumerate immersion in a bath of olive oil, covering the scalded surfaces with various paints and varnishes, dressings of many unguents, raw cream and red currant jelly; all being the suggestions of the kindliest desire to relieve suffering, although frequently emanating from a too limited experience. All I venture to claim for this is simplicity and readiness of application.

CATARACT.

By B. W. RICHARDSON, M.D.

DR. WEIR MITCHELL, of Philadelphia, in the year 1860, made the original and remarkable observation, that if a part of the body of a frog be immersed in simple syrup, there soon occurs in the crystalline lens of the eyeball an opaque appearance resembling the disease called cataract. He extended his observations to the effects of grape sugar, and obtained the same results. He found that he could induce the cataractic condition invariably by this experiment, or by injecting a solution of sugar with a fine needle, subcutaneously, into the dorsal sac of the frog. The discovery was one of singular importance in the history of medical science, and explained immediately a number of obscure phenomena. The co-existence of the two diseases, diabetes and cataract, in man, had been observed by France, Cohen, Hasner, Mackenzie, Duncan, Von Graefe, and others, and Von Graefe had stated that after examining a large number of diabetic patients in different hospitals, he had found one fourth affected with cataract. Before Mitchell's observation there was not a suspicion as to the reason of this connection, and a flood of light, therefore, broke on the subject the moment he proclaimed the new physiological fact. Still more Mitchell showed that the cataract he was able to induce by experiment was curable also by experiment, a truth which will one day lead to the cure of cataract without operation. Then, but not till then, the splendid character of this original investigation, and the debt that is due to one of the most original, honest, laborious workers that ever in any age cultivated the science and art of medicine, will be duly recognized.

When the news of Mitchell's discovery reached us here, I took up the investigation at the point where he had left it. The fact he had announced was found to be indisputable. From a patient in one of our large hospitals, who was suffering from diabetes and double cataract, a specimen of the sugar excreted was obtained, and from that specimen the cataractous disease was induced in the frog, and afterwards removed. The experiment was conducted with the animal kept in an anæsthetic atmosphere, and was found to answer just as well as in the ordinary atmosphere; in fact, the experiment succeeded best with frogs when it was rendered free of all pain, as spasmodic movements, which may occur if the process of production of cataract is rapid, and which may suddenly kill, are prevented. Since the introduction of chloral hydrate, that anæsthetic has become a still more useful agent in this research, since its own action runs in line with the experiment, and the anæsthetic can be introduced in actual combination with the substance producing the cataract.

In warm-blooded animals I learned that the cataractous change could be brought about immediately after death. Several of the experiments were made therefore on the head of the sheep after the animal had been killed at the slaughter-house in the ordinary way, the fluid being injected through an artery. In other warm bloods the death was first induced by one of the anæsthetic vapors, and the fluid used was either injected into the peritoneal cavity or through the aorta.

The line of research which I carried on in continuation of Dr. Mitchell's discovery was for the purpose of determining the cause of the cataractous change and the influence of other agents in producing it. It occurred to me that the change was possibly due to the influence of saline matter on the pure colloidal lens, and if this were true the cataract ought to be induced by other substances than sugar. Any of the soluble crystalloids might produce it, and as there are many of these in the blood, there might be other cataracts than such as are produced by sugar in the diabetic subject. The research was therefore pursued with all the soluble salts belonging to the blood, and with the result of producing cataractous change with them all. In the end it was deduced that whenever the specific gravity of the blood is raised by the presence of saline matter in it, to 10 degrees above the normal standard, and is sustained in that state for a short time, cataract is the result, and is maintained so long as the blood continues of the same specific weight. It was also found that the cataractous condition caused by the soluble blood salts was removable on the elimination of the added saline and the reduction of the blood to its natural equilibrium. At the same time there was observed to be a difference in the characters of the cataracts produced. Some of the saline cataracts were harder than the sugar cataracts, and less easily curable. Those salts which are most fixed in their chemical constitution and at the same time are most soluble, produce the hardest cataracts. Those salts which are most easily decomposed, such as urea, are least effective in inducing the pathological change.

The change was found to commence, as a rule, in the posterior part of the lens, and after beginning as an imperfectly defined hazy spot it extended gradually through the whole structure, causing a pearly whiteness and complete opacity. In the process of cleaning of the lens the posterior part was the last to become transparent, but without exception the whole structure of the lens regained its crystalline clearness and its perfect function when the specific weight of the blood was reduced to its natural standard, if the circulation of fluid through the lens continued.

In these experiments two illustrious scholars, now lost to science, took the warmest interest, the late Professor Graham and the late Sir David Brewster. Both lent to me their valued observation. Graham saw in the experimental facts the first application in physiological pathology of his great discovery of the mutual action of colloidal and crystalloidal substances. Sir David drew some most ingenious inferences as to the physical cause of the opacity, tracing it to a process of crenation on the margins of the fibres of the lens. The greatest interest was naturally excited throughout the medical profession. In this production of cataract the first visible demonstration was offered of the synthesis of a well-known disease. It is now certain that if the specific gravity of the blood be raised rapidly a few degrees by a crystalloidal substance, cataract is the direct result. Recently Dr. Sansom saw this event in the case of a young woman suffering from diabetes, who became in a few days stone blind from cataract in both eyes; and, indeed, the cause of diabetic cataract is now made quite plain. But the end of the discovery is not reached with this fact, important though it be. The mode of production, in man and the lower animals, of the slowly advancing cataract, from which so many persons are rendered permanently blind, is after the same process, with a different saline, acting in a slower degree; and the inference is fair that some particular forms of diet are conducive to the disease. When the whole series of facts which Mitchell commenced to unfold are completed, the disease cataract will be understood in full. Its physical pathology is already understood, and if the operative art of the surgeon be not quenched by another mode of cure resulting from his discovery, it will be by the better art of prevention of the disease.—*Nature.*

TAPE-WORM REMEDY.

By Prof. EDWIN FREEMAN, M.D.

I SUCCEEDED in obtaining a tape-worm entire, with its head, from W. S., of Avondale, which had resisted the use of a good many medicines during five years before I began to medicate its possessor for it. The worm obtained was thirty-four feet long when it came away. Mr. S. said that he passed, at some time past, forty-two feet in one piece, but the head remained, and he has every day passed several inches for at least three years. While he had the worm he was a large eater, and seemed to require besides a quart or two of coffee every morning. It caused him at times to become faint and dizzy, with occasional headache and weakness, and sluggishness in the morning. In addition to this, there were occasionally nausea and fulness of the stomach. The best evidence of the presence of tape-worm is the passage, with the fæces, of portions of one.

Treatment.—I gave him the first thing in the morning two seidlitz powders, which thoroughly evacuated the bowels. I then gave him morphia sulph. gr. ¼. In an hour he began to take the pomegranate, a decoction of the bark, four ounces every fifteen minutes, until it was all taken. The decoction was prepared by the chemist, J. U. Lloyd, from the best bark, according to the formula published by Prof. Locke in a former number of the *E. M. Journal*, and mixed with fluid extract jalap, dr. j.

After the third dose the worm was felt to have lost its hold on the bowel, and to be low down. The fourth dose was not taken until an hour after the third, hoping that the worm would surrender and come away. It was stubborn, however, but at the last dose submitted unconditionally, like Davy Crockett's coon, coiled himself into a knot, and got down and out.

The dose is a fearful one to swallow, but for those who can take it, it is effectual in ridding them of a very annoying trouble.—*Ec. Med. Jour.*

DIPHTHERIA SUCCESSFULLY TREATED.

DR. E. CHENERY, M.D., Boston, Mass., cites a very large number of cases, 158 within his own practice, saved by the use of hyposulphite of soda.

The dose of the hyposulphite is from five to fifteen grains or more in syrup, every two to four hours, according to age and circumstances. It can do no harm, but if too much is given it will physic. As much as the patient can bear without physicking is a good rule in the severer cases. The tincture can be used in doses of five drops to a half drachm in milk. The amount for thorough stimulation is greater than can be taken in water. I usually give it in such doses as can be easily taken in milk, using the milk as food for small children. One fact, however, needs to be borne in mind, namely, the hyposulphite prevents the digestion of milk, and should not be given in less than an hour from it. They may be used alternately, however, without interference, in sufficiently frequent doses.

Judging in this disease as I judge in others, I am fully persuaded that the treatment I have so long used, and which has not failed me yet, will save nearly every case of diphtheria if seasonably and vigorously employed, and there is no reason why it should not do as well in the hands of others as in my own.

In none of my cases have I used any alcohol.

SPECIFIC AGAINST HYDROPHOBIA.

DR. GRZYVALA, in the *British Med. Jour.*, claims for Xanthium Spinosum antirabic properties. Its efficacy has been tested in one hundred victims bitten by rabid animals, of whom he lost none. Some astonishing instances of the marvellous power of this drug are given, two of which are appended. Twelve persons of one family had been bitten by a mad wolf. Six of this number were admitted into the hospital of Olschanka, Government of Podolia, district of Balta, and were treated with this drug, and all recovered. All of the others, treated with the actual cautery and the daily use of *genista tinctoria* died with hydrophobia in from twelve to sixty days. Thirty oxen had been bitten by a mad wolf; five of them died hydrophobic. The remaining twenty-five were treated with Xanthium Spinosum and recovered. Of the dried leaves, powdered, the dose for an adult is nine grains, thrice daily. For children under that age, half that dose. For the animals above alluded to, the dose was three ounces daily, given in bran. Too warm a welcome to this new aspirant for the honors of specificity against hydrophobia can not be extended. The trustworthiness of Dr. Grzyvala is vouched for by Prof. Guber, of Paris.

HYPOSULPHITE OF SODA IN DIPHTHERIA.

THE remedy not only tends to diminish the temperature, but to destroy the cryptogam of the false membrane. The hyposulphite of soda is given in doses of from 6 to 20 grammes in from 100 to 300 grammes of distilled water, to which 30 grammes of syrup of orange peel are added. At the same time a gargle is administered, containing 40 grammes of the hyposulphite of soda in 400 of distilled water. The diet should consist of eggs, soup and wine. During convalescence the prolonged use of lactate of iron is recommended. Dr. Tamborlini reports numerous successful cases thus treated.

THE DIET FOR GOUT.

IN a note to the *British Medical Journal*, Dr. John Malcolm writes:—

My attention has been given, for many years, to the cause and cure of gout, to which I have a hereditary tendency, my father and grandfather having suffered greatly from this disorder. I soon ascertained that, by attention to diet alone, I could prevent the disease, and for more than thirty years I have steadily adhered to a diet consisting of farinaceous food and fruit, with milk and cream, by which means I have escaped any illness. Among my patients, I have found that (when I could not induce them to give up animal food), by partaking only of fish, fowl, and rabbit—white meats—their attacks of gout have been of a milder and less frequent character; but in no case have I been able to cure the disease unless I could induce a total abstinence from all flesh food.

THE RELIEF OF PRICKLY HEAT.

MANY persons are very subject to this annoying affection. They will be glad to learn that Surgeon-Major Dr. J. G. French, of the Indian medical service, in a contribution to the *Indian Medical Gazette*, says that we can cure prickly heat in three or four days by the application of a solution of sulphate of copper. This should be of the strength of about ten grains to the ounce of water, and the solution should be applied daily, or oftener, by means of a camel-hair brush, or bit of sponge tied on the end of a stick. It is best applied after the morning bath, when the skin has been well rubbed with the towel, and it must be allowed to dry on the skin before dressing. Dr. French states that he has used this application for over thirteen years, and, when regularly and properly applied, he has never known it to fail.

THE TREATMENT OF CANCER.

AN English journal states that in the University College Hospital, London, in cancer cases, the application of stramonium ointment was found to give great relief to pain. Mr. Henry Morris had good results in a severe case of epithelioma, involving nearly half the scalp, with "Fell's Paste" (chloride of zinc, flour, and liquor opii sedativus, sufficient to form a paste). The first application produced an eschar, which was cut through so that the remedy could be applied deeper, and applications having been made daily, or on alternate days, for about a month, the whole mass came away, leaving the bone exposed; finally, a thin sheet of this exfoliated, the wound healed, and the patient has remained well for several months since.—*Med. and Surg. Reporter.*

FUNCTIONS OF THE OPTIC THALAMI.

IN the last volume of the West Riding Lunatic Asylum Reports, Dr. C. Browne has a paper on the Functions of the Optic Thalami. The latter contains a considerable number of facts in support of the view that the optic thalami are the chief centres for common sensation, and are also important centres for reflex action. The writer has observed that in most cases of lesion of a thalamus, the hemiplegia which results is accompanied by a very remarkable and permanent abolition of reflex action in the paralyzed limbs. This is, at first sight, difficult to reconcile with the increase in spinal reflex activity which follows section of the cord at a higher point. Several theories to account for the discrepancy are proposed and discussed, and the conclusion reached is that every reflex action involves a double current of molecular change, one direct through the cord; the other, through a "loop line" which extends up to the thalamus, is concerned in the liberation of higher reflex movements, etc., and is essential, also, for the liberation of the motor impulse of the lower spinal reflex action. He believes that the integrity of the path to the thalamus is sufficient to prevent the spinal over-action which occurs when that path is blocked in division of the cord.

ACTION OF HYDROCYANIC ACID ON INSECT LIFE.

IT has been noticed by A. Gautier (*Bull. Soc. Chim. Paris*) that rabbits which have been poisoned with anhydrous hydrocyanic acid may be restored to life some minutes after death has apparently intervened, by inducing artificial respiration of air containing chlorine. He now finds that insects which have been subjected to the same treatment, and which are apparently dead, can in like manner be restored by the agency of chlorine.

ALUMINIUM.

It is now about twenty years since the celebrated French chemist, Deville, succeeded in demonstrating the possibility of producing the metal aluminium upon a large scale; but, up to the present, the extent to which this interesting and praiseworthy invention has been utilized has but to a slight degree realized the sanguine expectations which intelligent minds of all professions have been accustomed to associate with it. So important, indeed, were the fruits of Deville's first investigations deemed to be, that they were at once invested with the dignity of royal patronage, and the first works for the manufacture of the new metal were shortly thereafter erected at Javelle, near Paris, from the private purse of the late Emperor of the French. It was expected that the new product would at once find its way into the useful arts as an effective and valuable substitute for many other metals. That these expectations were well founded will be apparent from the characteristic and very exceptional properties of the metal. A bright, pure surface of aluminium possesses a greyish white color, something between that of zinc and tin. Its extreme lightness is one of its very distinguishing properties, and affords an immediate means of identifying it from every other metal. Its specific gravity is but 2.5 (water=1), from which it appears that it is about three times lighter than copper, four times lighter than silver, and nearly eight times lighter than gold. When struck, it emits a loud, clear, musical tone, which has been compared with that of crystal glass. The keen observing powers of the French chemist did not permit this property to pass unnoticed. He suggested the employment of aluminium for bell-metal, and in the year 1868 presented to the Royal Institution of Great Britain a bell 1½ foot in diameter, which proved to possess a most exquisite tone, and which, despite its not inconsiderable dimensions, weighed no more than 44 lbs.

The metal may be hammered out into the thinnest leaves, rolled into plates or sheets, and drawn into the finest wire. Its hardness approaches that of fine silver, and its tensile strength equals that of copper. Its melting point lies at 700° C. (about 1300 F.), or between that of zinc and silver; and it is worthy of note that it fuses with extreme slowness, and does not vaporize even in the heat of the blast furnace. Generally speaking, the metal is workable to an extraordinary degree, and it may be filed, turned, pressed, engraved, and coined quite readily. In compact masses the metal is quite indifferent to atmospheric influences, and even when being smelted it does not sensibly oxidize. It must be remarked, however, that the properties above enumerated are predicted upon the presumption that the metal is free from impurities.

In the manufacture of jewelry, and other articles of luxury, it is probable that aluminium may in time play an important part, though it is scarcely possible for it to ever rival the popularity of silver in these uses. In Paris, which, by the way, has always remained the headquarters of the aluminium industry, it appears to be employed to a considerable extent for elegant inlaid work upon jewel and dressing cases, fans, etc., for lids and covers of glasses, and for a variety of small articles of *galanterie*. From what has been done in this direction we can estimate its fitness for a thousand elegant articles of taste, fancy, and utility, when once its popularity is established before the world at large, which is now scarcely cognizant of the existence of such a metal as aluminium. The makers of clocks and watches, of surgical and musical instruments, and of artificial teeth, as well as the manufacturers of such articles as seals, penholders, paper-weights, shirt and sleeve buttons, smokers' and sportsmen's necessaries, canes, riding-whips, harness decorations, statuettes, gas fixtures and lamps, etc., would without doubt derive much advantage and profit from the employment of aluminium, and sooner or later its peculiar fitness for these uses will be recognized. For the manufacture of philosophical and engineering instruments, and especially the latter, the indifference of aluminium to atmospheric influences, and its extreme lightness, have of late met with general recognition, and the employment of the metal for these uses is steadily growing in favor.

According to M. Morin, the director of the manufactory of Nanterre, very homogeneous alloys are obtained with copper and 5, 7½ and 10 per cent of aluminium. The alloys with 5 and 10 per cent of aluminium are both of a golden color, whilst that with 7½ per cent has a greenish tint. Even so small an addition as 1 per cent of aluminium to copper considerably increases its ductility and fusibility, and imparts to it the property of completely filling the mould, making a dense casting free from air-bubbles. At the same time the copper becomes more resistant of chemical re-agents, increases in hardness without losing in malleability, and unites in itself the most valuable qualities of bronze and brass. A copper alloy with 2 per cent of aluminium is said to be used in the studio of Christofle, in Paris, for works of art. It works well under the chisel and graver.

The true aluminium bronzes, according to Rudolph Wagner, were first made by John Percy, in 1856. They are alloys containing 90 to 95 per cent of copper, with 10 to 5 per cent of aluminium. The direct mixture, by first fusion, of 10 parts of aluminium and 90 of copper, gives a brittle alloy, which, however, increases in strength and tenacity by several successive fusions. At each operation a little aluminium is lost. After the compound has been melted three or four times, however, the proportion of aluminium does not appear to change, and the alloy may be again remelted several times without alteration. These fusions are effected in crucibles. The aluminium bronze is homogeneous, and possesses sufficient expansion to fill the remotest parts of the mould. It affords sharp castings that can be worked more readily than steel. Aluminium bronze may be forged at a dull-red heat, and hammered until cooled off without presenting any flaws or cracks. Like copper, it is rendered milder and more ductile by being plunged into cold water when hot. The bronze polishes beautifully, and possesses great strength—according to Anderson's experiments, an average of 75,618½ lbs. per square inch. The resistance to compression is feeble. From the experiments of Col. Strange on the relative rigidity of brass, ordinary and aluminium bronze, it appears that the last named is forty times as rigid as brass, and three times as rigid as ordinary bronze.

Aluminium is manufactured by decomposing the double chloride of aluminium and sodium, with the aid of metallic sodium. The sodium is obtained by heating to redness a mixture of 100 parts of calcined soda, 15 parts of chalk, and 45 parts of coal. The chloride of aluminium is prepared by passing chlorine gas over a moderately heated mixture of pure alumina (obtained either from alum or the mineral bauxite), common salt and coal tar. This operation is conducted in an iron gas retort, and the result of the interaction of the several substances present is the combination of the coal tar with the oxygen of the alumina, and the production of aluminium chloride, which unites with the chloride of sodium (common salt), forming a double salt, which volatilizes and is passed off into a separate chamber, where it condenses. From this method of obtaining the chloride, it is impossible to keep it free from chloride of iron, for which reason the Parisian aluminium is invariably impurified therewith. From this double chloride of aluminium and sodium the metallic aluminium is obtained, either by passing it in the form of vapor over a heated surface of metallic sodium, in a simply constructed and connected system of iron cylinders appropriately heated, or the materials are at once mixed and heated.

Rose, of Berlin, instead of the artificially prepared aluminium chloride, employed the mineral kryolite (a natural compound occurring in deposits of considerable magnitude in Greenland, and consisting of fluoride of aluminium and sodium) quite successfully. By heating this mineral with sodium, metallic aluminium and fluoride of sodium are produced, and the latter compound is gotten rid of by treating the resulting mass with caustic lime. Of late the metal has also been manufactured from the mineral bauxite.

At present there are four aluminium works in existence, of which three are in France and one in England. Their total production amounts to about 3500*l*. yearly, of which 2000*l*. are produced in France, and 1500*l*. in England.

CARVED PANEL ORNAMENTS FROM GOTHIC STALLS, TARNOW CATHEDRAL, GALICIA, FIFTEENTH CENTURY.—*From the "Workshop."*

FERNS IN THE PARLOR.

Mr. Milton writes to the *Germantown Telegraph*: Ferns are plants the culture of which is very interesting, either in the greenhouse or parlor. Nothing adorns a sitting-room more than a case of ferns in luxuriant health in the midst of winter, when vegetation is at rest outdoors, and nothing meets the eye but bare trees and showers of snow. A case for this purpose may be made of any size, and almost any shape. In their construction, however, several particular points have to be borne in mind, for the benefit of the plants which are to grow in them, the first of which is a means of obtaining a thorough drainage. More failures occur in the cultivation of plants in Wardian cases, from imperfect drainage, than from any other cause, nothing being more injurious to the plants than sour, stagnant soil; and however porous the soil itself may be, without perfect drainage it cannot be long in a condition suitable for supplying a healthy food for plants; the water retained in the soil having no means of escape, soon sours it. To secure good drainage, also dryness and tidiness in that part of the room where the case stands, two bottoms are necessary; one, the true bottom, which should be thoroughly perforated to allow the free escape of the water; below this one, another should be placed to receive the water as it passes from the soil, and therefore requires to be water-tight, and so adjusted that it can be emptied and cleansed without disturbing any other part of the case. On the upper bottom place a good thick layer of potsherds and charcoal for drainage. Upon this put a small mound of suitable soil for ferns—peat, loam, and a good mixture of sand—secure to this mound small stones and shells, so as to imitate a small rock-work, allowing sufficient cavities for planting ferns and mosses.

Proper means of ventilation is also necessary, which is best acquired by having part of the roof movable. When so constructed that the movable part can slide over the fixed part, it gives the least trouble, and is the most convenient when cleaning, watering, or planting the ferns. Top ventilation is better for the welfare of the plants than when side ventilation is adopted, as then there is no ill effects arising from cold draughts passing through them.

When planting the ferns, put some erect growing kinds at the top, and the more dwarf and bushy ones on the sides of the mound, using mosses for carpeting the whole—mosses of the denticulata type; those of the caulescent kinds which succeed in these cases look best mixed through the ferns. Upon removing the plants from the pots, do not break up the balls any before planting; the roots will soon make a start into the fresh soil, which should be pressed rather firmly around the roots. After the plants are in, give a good watering, and shut close for a few days. In selecting plants for such purposes, dwarf-grown plants, in small pots, are the best.